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(54) System for re-transmission in data communication

(57) An SR (Selective Repeat) ARQ system with limited buffer memory is realized by modifying a part of a user data area. A transmitter side modifies a part of a user data area in a data frame so that it differs at least one bit from corresponding part of a frame with the same frame number as that of a current frame in a preceding modulo, and a receiver side compares said part of a user data area with corresponding part of a frame with the same frame number as that of a current frame in a preceding modulo. When they coincide, the receiver side disregards the received frame as it is re-transmitted frame which is already received correctly, and when they do not coincide, the receiver side takes the received frame. Preferably, said part of a user data area is the last word area in a user data area in a frame structure.

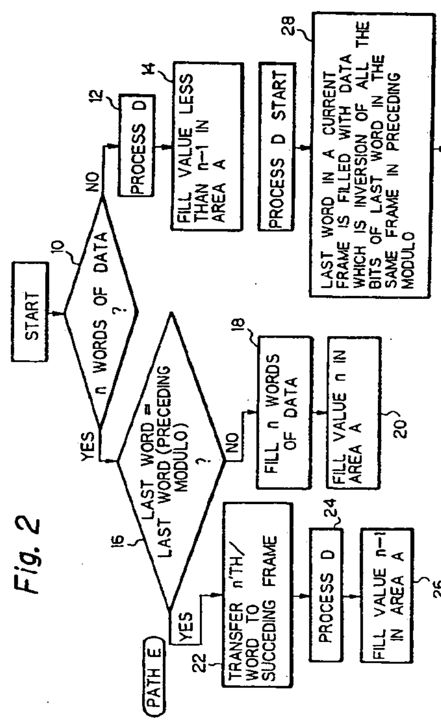

Fig. 2

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Description

BACKGROUND OF THE INVENTION

The present invention relates to an ARQ system, or a system for autmatic request (or repeat) transmission in data communication system, in particular, relates to such a system which provides error-free transmission with high efficiency in a mobile communication system which has mainly burst errors.

A prior ARQ system in data communication system which has a feedback channel is a selective repeat (SR) system.

Fig.5 shows the operational time chart of an ideal SR system, in which it is assumed that a receiver has ideally infinite amount of buffer memories. In Fig.5, symbol S_i (i is integer) shows a frame number which is assigned to each data frame in a transmitter side, and R_i shows a frame number which is returned from a receiver side to a transmitter side through a feedback channel. A transmitter side, upon receipt of a frame number R_i, recognizes that a receiver side receives correctly a frame R_{i-1}, and a receiver side requests a transmitter side to send a next frame S_i. It is assumed in Fig.5 for the sake of simplicity of explanation that no error occurs in a feedback channel. In Fig.5, the symbol O shows that a frame is received correctly, and the symbol X shows a frame is not received correctly.

The SR ARQ system has the feature that a transmitter side repeats the transmission of an only frame which is requested by a receiver side. Further, a transmitter side disregards a repeat request R_i which is received by the transmitter side within round-trip-delay (RTF), since it is much possible that a correct frame which is repeated to a receiver side has not been received yet by a receiver side. The value of RTF is pre-determined in each system in a design stage of a system, considering delay time between a transmitter side and a receiver side. In the embodiment of Fig.5, the value of RTF is time for four frames.

In Fig.5, the receiver side (RX) receives the frame S_0 correctly, and therefore, returns a request frame R_1, requesting to send the frame S_1. The frame S_1 is also received correctly. However, the frame S_2 is not received correctly, and therefore, the request frame R_2 is returned to the transmitter side. The request frame R_2 is sent to the transmitter side until the frame S_2 is received correctly. The transmitter side recognizes R_2 after the frame S_5 is transmitted, and so, the frame S_2 is re-transmitted after S_5, and the frames S_6, S_7 and S_8 follow. Although the transmitter side receives the request frame R_2 at the timing of S_6 and S_7 after it re-transmits S_2, those request frames are disregarded since it is within RTF time since S_2 is re-transmitted. The re-transmitted S_2 is received correctly. So, the receiver side requests R_5 since S_5 is not received correctly, and so, the transmitter side re-transmits the frame S_5 after the frame S_8.

The SR ARQ system has disadvantage that each of a transmitter side and a receiver side must install infinite amount of buffer memory, and/or infinite numbers for data frames, in order to assure the correct sequence of receive frames in a receiver side, since a frame must be stored in a transmitter side and a receiver side until correct reception of each frame is acknowledged in a transmitter side, although the SR ARQ system has advantage that the transmission efficiency is excellent.

However, in an actual transmitter and an actual receiver, amount of buffer memory, and/or number of frames is not infinite, but is finite repeating with modulo M. Therefore, it is absolutely impossible to implement an ideal ARQ system shown in Fig.5.

Fig.6 shows the operational time chart of another prior SR system, in which the modulo is 8, in which S_i and R_i show number of a frame in a transmitter side and a receiver side in a first modulo turn, respectively, and S_i+ and R_i+ show number of a frame in a transmitter side and a receiver side in a succeeding modulo turn, respectively. It is noted in Fig.6 that a frame number (i of S_i, R_i, S_i+, R_i+) is one of 0 through 7, because a value of modulo is 8.

Theoretically speaking, the maximum frames which are allowed to a transmitter side to send with no acknowledge from a receiver side in an SR ARQ system is (modulo - 1) frames, on the condition that the sequence of frames in a receiver side is kept. That number (modulo - 1) is called an outstanding number. When the modulo is 8, the outstanding number is 7.

It should be noted that a receiver side can not differentiate a frame S_i and a frame S_i+ in a receiver side since those frames have the same frame number (i) as each other, although they are differentiated in the figure for the sake of easy explanation. If a transmitter side sends frames more than the outstanding number, a receiver side can not identify two frames which have the same frame number as each other, which modulo each of the frames belongs, and therefore, the sequence of the frames in a receiver side is not kept.

In wired data communication systems, the number of modulo is designed to be large enough in a system design so that no frame having the frame number close to the outstanding number is transmitted, considering transmission quality. On the other hand, in radio communication systems, in particular, in a mobile communication system, it is impossible to have large modulo, if we consider an intermittent breakdown of a communication system due to a channel switching and/or hand over, and power consumption allowable for a portable terminal set.

One solution for the above problem is the combination of an SR ARQ system and a GBN (Go-back-N) ARQ system which has less transmission efficiency than an SR ARQ system but has no problem of differentiation of modulos.

Fig.7 shows the operational time chart of a prior system which is the combination of an SR ARQ system, and a GBN ARQ system. The prior GBN system has the feature that a transmitter side re-transmits all the frames be-

tween the first frame that a receiver side request the re-transmission and the latest frame which the transmitter side has sent. In Fig.7, a transmitter side has transmitted the frame S_0+ at time A, where the acknowledgement of S_1 is acknowleged by the reception of R_2, but no acknowledgement of S_4 is acknowledged, since the feedback channel for R_5 was in error. The number of frames which can be transmitted at time A is $(2+6)_{modulo\ 8}=0$. This means that no further frame must not be sent since 6 frames (S_3, S_4, S_5, S_6, S_7, S_0+) have been sent after S_2 which is the oldest frame that is not acknowledged. Therefore, the transmitter system is switched to the GBN ARQ system from the SR ARQ system, since if the transmitter side sends more frames, it exceeds outstanding number (=7). Next, during the transmission operation under the GBN ARQ system, the number of frames which can be transmitted at time B is $(5+6)_{modulo\ 8}=3$, where the frame S_5 is the oldest frame which is not acknowledged, and since that number (=3) is equal to or larger than 1, the transmission system is switched to the SR ARQ system, which is more efficient than the GBN ARQ system.

The prior system for the operation of Fig.7 has the disadvantage that a frame structure must include at least one bit for indicating a flag which one of an SR system and a GBN system is used currently, and the presence of that flag decreases the transmission efficiency, and the system design of a communication system for adding that flag in a current communication system is complicated.

By the way, if we wish to operate only an SR ARQ system with no switching to a GBN ARQ system, a receiver side must differentiate two frames which have the same frame number as each other and appear for each modulo turn, for at least two modulo turns.

So, the other prior art is to have a modulo identifier in a frame structure so that which modulo a frame belongs.

Fig.8 shows two examples of prior arts, which have a SR/GBN flag or a modulo identifier in a frame structure. In the figure, the numeral A is an area showing amount of words of a user data in the frame, B is an area containing a user data for communication, C is a frame number filled in a transmitter side, repeating the modulo M, D shows a frame number which a receiver side requests the transmission, E is a test bit (for instance a CRC bit) which is filled in a transmitter side so that a transmission error is detected in a receiver side. The symbol F is a flag showing the current operation system which is one of an SR ARQ system, and a GBN ARQ system, used in the embodiment of Fig.7, and the symbol G is a modulo identifier showing which modulo a flame belongs. The area D for showing a request frame is included in the frame structure, as it is assumed that the feedback channel uses the same frame structure as the forward frame structure.

Fig.9 shows a block diagram of a prior ARQ system which has a modulo identifier of Fig.8B, including both a transmitter side and a receiver side. In the figure, in a receiver side, a received signal is applied to an error detector 40, which tests if a transmission error occurs by checking an error detecting code in the area E which is filled in a transmitter side. When no transmission error is detected, the received signal is applied to a frame analysis circuit 42, and when a transmission error is detected, the received signal is disregarded. The frame analysis circuit 42 takes a frame number of the received frame, and sends said number to the transmit frame decision circuit 52. At the same time, the frame analysis circuit 42 forwards the whole received frame to the modulo identifier detector 44, which takes the frame number C and the modulo identifier G in the frame structure, and decides whether the current frame which is now received is a newly received frame or a re-transmission frame which has been received before. When it is a re-transmission frame, it is disregarded, and when it is a newly received frame, it is applied to a receiver data buffer 46, and simultaneously, the modulo identifier detector 44 sends the frame number which is acknowledged the safe receipt to the request frame decision circuit 54 and the receive data extract control circuit 48.

As it is an SR ARQ system in Fig.9, no sequence of received frames is guaranteed in a receiver side. Therefore, the received data extract control circuit 48 controls the transfer of data from the data buffer 46 to the output interface buffer 50 so that the sequence of receive data is kept.

The transmit frame decision circuit 52 decides a next frame which is to be sent based upon the requested frame number D, and instructs the transmit data buffer 62 the next frame to be sent. Simultaneously, the circuit 52 instructs the transmit data produce control circuit 56 the frame number which is to be updated by a new data frame. The request frame decision circuit 54 decides the request frame based upon the frame number C of the received frame from the receiver side, and instructs the request number assign circuit 64 the request frame. The transmit data produce control circuit 56 instructs the modulo identifier assign circuit 60 the frame numbers which carry new data frames. The modulo identifier assign circuit 60 assigns the modulo identifier to the output data of the input interface buffer 58 so that a frame is recognized which modulo it belongs, and the modulo identifier together with the user data are stored in the transmit data buffer 62. The transmit data buffer 62 sends the request number assign circuit 64 a data frame based upon the instruction by the transmit frame decision circuit 52.

The request number assign circuit 64 assigns the value which is sent from the request frame decision circuit 54 into the request frame number area D in the frame structure, and sends the frame to the error detection code assign circuit 66. The error detection code assign circuit 66 fills an error detection code (for instance, a parity bit, or a CRC (cyclic redundancy check) code), and the whole frame is forwarded to a communication line.

However, a prior ARQ system, the combination of an SR ARQ system and a GBN ARQ system, and/or an SR ARQ system having a modulo identifier have the disadvantages as follows.

In case of combination of an SR ARQ system and a GBN ARQ system, it switches often to a GBN ARQ system when many burst errors occur because of deep fading in mobile communication system, and that switching would cause the undesirable decrease of throughput. Further, as a flag for indicating whether it is an SR ARQ system, or a GBN ARQ system must be included in a frame structure, the amount of data area available to a user is decreased. Further, since two systems, an SR ARQ system and a GBN ARQ system are operated, the structure of an apparatus is complicated.

Fig.10 shows the operational time chart of a prior ARQ system, in which Fig.10A shows the time chart in case of the combination of an SR ARQ system and a GBN ARQ system, and Fig.10B shows the case of the modulo identifier type.

It is assumed that the modulo is 8 both in Fig.10A and Fig.10B.

In comparing Fig.10A with Fig.10B, a receiver in Fig.10A acknowledges the correct receipt of the frame 5 at time B (frame 6 is requested by R_6) because of the switching to a GBN ARQ system due to continuous errors, while in Fig.10B a receiver acknowledges the correct receipt of the frame 0+ at time B. Therefore, it appears that the modulo identifier type of Fig.10B is better than the case of Fig.10A.

However, the modulo identifier type of Fig.10B has the disadvantage that it must have an identifier for indicating a modulo turn in a frame structure, and the presence of said identifier decreases a throughput. Further, as a control in a hardware is carried out for a byte which has 8 bits, the presence of a modulo identifier occupies at least 8 bits, although an identifier itself has only one bit.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a new and improved ARQ system by overcoming the disadvantages and limitations of a prior ARQ system.

It is also an object of the present invention to provide an ARQ system which operates under an SR ARQ system with no switching to a GBN ARQ system.

It is also an object of the present invention to provide an ARQ system which operates under an SR ARQ system with infinite number of frames, no modulo identifier, while keeping the sequence of receive frames.

The above and other objects are attained by system for re-transmission through an Selective Repeat system in a data communication for a data frame having a forward channel and a feedback channel, having a transmitter side and a receiver side comprising; said data frame comprises at least; a first area (B) for carrying a user data, a second area (C) for carrying a frame number of each frame, said frame number being incremented one by one for each frame with a predetermined modulo M, a third area (D) for carrying a repeat request number which is forwarded from a receiver side to a transmitter side requesting transmission of a frame, and a fourth area (E) for carrying an error detection code for a frame, a fifth area (A) for carrying a number which shows how much user data is filled in said first area (B), said transmitter side comprises at least; a transmit buffer memory (62) storing said first area (B), said fifth area (A) and said second area (C) of said frame by at least a modulo number of frames, frame assemble means (70) for assembling a frame with a user data and modifying a part (B_n) in said first area (B) so that said part (B_n) differs from the corresponding part in a frame having the same frame number as that of a current frame in a preceding modulo, and storing assembled frame in said memory (62), means (52) for deciding a frame for transmission according to a request number in the area (D) of a request frame from a receiver side, where a request frame within a predetermined round trip delay time is disregarded, means (66) for filling said fourth area (E) with an error detection code, and transmitting an assembled frame to a receiver side, a receiver side comprises; means (40) for detecting a transmission error in a frame by using an error code in said fourth area (E), a receive buffer memory (46) storing receive frames by at least a modulo of frames, means (54) for deciding a request frame to a transmit side with a request frame number (D) which is next frame of the latest received frame defined in the area (C) in case of no transmission error, or a frame which an error is detected, means (64) for filling said area (D) with a request frame number according to the decision by said means (54), and transmitting a request frame to a transmitter side, and means (66) for transmitting an output of said means (64) to said transmitter side with filling an error detection code to said output of said means (64), wherein the improvements comprise in that; said receiver side comprises further comparison means (68) for comparing said part (B_n) in a first area (B) in a current received frame with corresponding part (B_n) in corresponding frame having the same frame number as that of said current received frame in a preceding modulo stored in said receive buffer memory (46), and deciding whether to disregard said current received frame when former coincides with latter since said current received frame has previously been received, or to take said current received frame and update content of said receive buffer memory (46) with said current received frame when former differs from latter since said current received frame is a newly received frame.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features, and attendant advantages of the present invention will be appreciated as the same become better understood by means of the following description and accompanying drawings wherein;

Fig.1 is structure of a data frame according to the present invention,

Fig.2 shows an operational flow chart for assembling a data frame in a transmitter side, according to the present invention,

Fig.3 shows an operational flow chart in a receiver side, according to the present invention,

Fig.4 shows a block diagram of a re-transmission system in data communication according to the present invention,

Fig.5 shows an operational time chart of an ideal SR ARQ system,

Fig.6 shows an operational time chart in an actual SR ARQ system with the modulo number 8,

Fig.7 shows an operational time chart in a prior art which is the combination of an SR ARQ system and a GBN ARQ system,

Fig.8 shows two examples of a structure of a data frame in a prior art,

Fig.9 is a block diagram of a prior repeat request system for data communication, and

Fig.10 shows an operational time chart in a prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The basic idea of the present invention is an improvement of an SR ARQ system with infinite modulo number, but with no modulo identifier. The function of a modulo identifier is provided by modifying a user data itself.

Fig.1 shows a structure of a data frame according to the present invention. The structure of Fig.1 is essentially the same as the structure of a prior SR ARQ system. In the figure, the symbol A is an area carrying a value how many words a user data area B carry, B is a user data area for carrying a user data to be communicated. The user data area B has capacity to keep n words of data (n is integer larger than 2), and the last word B_n in the data area B is used for special purpose in the present invention. The symbol C is a frame number area showing a frame number of a frame. The frame number repeats with the modulo M, so that the frame number is between 0 and M-1. The frame number is attached in a transmitter side. The symbol D is a request frame area, which is attached in a receiver side. When a transmission error is detected, it is a repeat request, and when no error is detected, it is a request of a next frame. When a transmitter side receives a request frame from a receiver side, and the content of the request frame area D is, for instance p, (p is in the range between 0 and M-1), the transmitter side recognizes that the frames up to p-1 have been received correctly, and the receiver side requests the frame of the frame number p. A receiver side may request a frame p either when the frames up to p-1 are received correctly, and requests a next frame p, or when there is a transmission error in a frame p. The symbol E is an error detection area for carrying an error detection code to detect a transmission error of a frame. The error detection code is for instance a parity bit, or a CRC code. It is assumed in Fig.1 that the same frame structure is used in a feedback channel from a receiver side to a transmitter side.

Fig.2 shows an operational flow chart for deciding the last word B_n in the user data area B in the frame structure in assembling a frame in a transmitter side. The last word B_n is used to find a modulo turn of a frame in the present invention.

In Fig.2, when the operation starts, the box 10 decides whether the user data for transmission has n words or not, where the value n is the maximum words included in an user data area B in each frame.

When the user words to be sent in a current frame are less than n, it goes to the box 12, which carries out the box 28. The box 28 fills the last word area B_n of the user data area B in a current frame with a data which is in inversion of all the bits of the last words B_n in a user data area B of a frame of the same frame number as said current frame in the preceding modulo. The box 14 fills the area A with a value which shows number of user words carried in the area B. Since the area B has capacity of n words, and the user words which should be sent are less than n words, the value in the area A is equal to or less than n-1.

When the box 10 recognizes that there are n words of user data for transmission, the box 16 tests whether all the bits in the last data word B_n in the frame of the same frame number as that of the current frame in the preceding modulo are completely the same as the bits in the last data word (n'th word) in the current frame in the current modulo. When the former (all the bits in the last data word in the frame of the same frame number in the preceding modulo) are completely the same as the latter (all the bits in the last data word in the current frame in the current modulo), the control goes to the path E, and the box 22 transfers the last word (n'th word) to the succeeding frame, in other words, the current frame carries n-1 words and the last word (n'th word) is transmitted in the next frame. Then, the box 24 carries out the box 28 in which the last word B_n in the user data area B in the current frame is filled with a data which is the inversion of the last word B_n in the user data area B of a frame of the same frame number as that of the current frame, in the preceding modulo. The box 26 carries out to fill the area A with a value n-1, since n-1 user words are kept in the area B.

When the box 16 recognizes that all the bits in the last data word B_n in the user data area B of the current frame are not the same as the last data word B_n in the user data area B of a frame of the same frame number as that of the current frame, in the preceding modulo, the box 18 is carried out so that all the n data words are inserted in the user data area B. And, the box 20 fills the area A with value n.

In the above operation, it should be appreciated that the last word B_n in the user data area B in the corre-

sponding frame in a preceding modulo does not completely coincide with the last word B_n in the user data area B in the current frame in the current modulo. This feature is used in a receiver side to differentiate a frame in another modulo turn, merely by comparing the last word B_n in a current frame with the last word B_n in the corresponding frame which has the same frame number in a preceding modulo.

In Fig.2, when the path E occurs, the last word in the user data area B is used only for differentiating modulos. However, the probability of the path E is very small, and in theoretical analysis, it is less than 0.4 % provided that each word has 1 byte with bits (8 bits).

Fig.3 shows the operational flow chart for differentiating modulo in a receiver side according to the present invention. When it starts, the box 30 reads a frame number of a frame in the area C. Then, the box 32 compares the last word B_n in the user data area B of the corresponding frame in a receive buffer 46 (which stores frames in a preceding modulo), with the last word B_n in the data area B in the current frame in the current modulo. When they coincide with each other, it means that the current frame is the re-transmitted frame which is already received correctly, and the current frame is disregarded.

When they do not coincide with each other, the box 34 processes the current frame as the correct frame, and the box 36 updates the content of the current frame area in the receive buffer 46 with the current received frame.

It should be appreciated that a receiver side may differentiate a modulo turn merely by comparing the last word in a user data area in a current frame with the last word in the corresponding frame which has the same frame number in a preceding modulo, and may determine whether a frame is re-transmitted, or it is a newly transmitted frame. Also, it should be appreciated that to keep a prior SR protocol, the buffer memory 62 and the buffer memory 46 must have the capacity enough to store a modulo number of frames (modulo number M is for instance M=8). So, it should be appreciated that the extra buffer memories are not needed for realizing the present invention.

The operational time chart of the present invention is the same as that of Fig.10B for a prior modulo identifier type.

In Fig.10B, the transmitter side sends frames S_0 through S_5, and since S_2 is in error and receives a request frame R_2 which requests to send S_2, the transmitter side sends S_2 after S_5, then, sends S_6, S_7, and S_0+, where S_0+ is a frame of frame number 0 in a succeeding modulo. However, since S_2 is again in error, it is re-transmitted again after S_0+. Then, S_3, S_4 and S_5 are sent. Those frames S_2, S_3 and S_4 are sent although they have been sent correctly, since the receiver side returns a request frame R_2, but does not acknowledge the safe receipt of S_3, S_4 and S_5. However, as S_2 is still in error, S_2 is re-transmitted again after S_5. And, S_6, S_7 and S_0+ are sent. That frame S_2 is received correctly with no error, and therefore, the receiver side stops to return a request frame R_2 which requests S_2 and return a request frame R_6 requesting S_6. However, since that request frame R_6 is not received by the transmitter side because of an error, the transmitter side does not recognize that S_2 is received correctly, and sends S_2 again after S_0+.

At that point, the receiver side would confuse whether the received frame S_2 is S_2 (=Y) or S_2+ as it has already received S_0+. According to the present invention, a receiver side carries out the operation in Fig.3, and found that the last word of the current frame S_2 (=X) is the same as the last word of the corresponding frame (Y) stored in the memory 46, and recognizes that the current S_2 (=X) is a re-transmitted frame, and should be disregarded.

In the present invention, the number of user words to be able to transmit in a frame is decreased to n-1 words although a frame has capacity to transmit n words, nevertheless, the present invention is useful since the probability of the above occasion (path E in Fig.3) is very small. In a prior art, a frame structure must have one bit for differentiating a modulo, or an SR system and a GBN system, and further, the presence of one bit means that it must have one word which has 8 bits.

Fig.4 shows a block diagram of the present ARQ system. The feature of Fig.4 as compared with Fig.9 is that a modulo identifier assign circuit 60 in Fig.9 is replaced by a transmit frame assembling circuit 70, and that a modulo identifier detector 44 in Fig.9 is replaced by a data comparator 68. Also, in Fig.4, a signal line from a transmit data buffer 62 to a transmit frame assembling circuit 70, and a signal line from a receive data buffer 46 to a data comparator 68 are provided. The operation of the transmit frame assembling circuit 70 is shown in Fig.2, and the operation of the data comparator 68 is shown in Fig.3.

As mentioned above in detail, the present invention provides error-free transmission with high transmission efficiency in a communication circuit for a mobile communication having many burst errors, with simple structure and with no additional bit in a frame structure.

Some modification is of course possible to those skilled in the art. For instance, the last word B_n for comparison is not restricted to the last word, but any portion of a user data area may be used instead of the last word.

From the foregoing it will now be apparent that a new and improved ARQ system has been found. It should be understood of course that the embodiments disclosed are merely illustrative and are not intended to limit the scope of the invention. Reference should be made to the appended claims, rather than the specification as indicating the scope of the invention.

Claims

1. System for re-transmission through an Selective Repeat system in a data communication for a data

frame having a forward channel and a feedback channel, having a transmitter side and a receiver side comprising;

said data frame comprises at least;
a first area (B) for carrying a user data,
a second area (C) for carrying a frame number of each frame, said frame number being incremented one by one for each frame with a predetermined modulo M,
a third area (D) for carrying a repeat request number which is forwarded from a receiver side to a transmitter side requesting transmission of a frame, and
a fourth area (E) for carrying an error detection code for a frame,
a fifth area (A) for carrying a number which shows how much user data is filled in said first area (B),
said transmitter side comprises at least;
a transmit buffer memory (62) storing said first area (B), said fifth area (A) and said second area (C) of said frame by at least a modulo number of frames,
frame assemble means (70) for assembling a frame with a user data and modifying a part (B_n) in said first area (B) so that said part (B_n) differs from the corresponding part in a frame having the same frame number as that of a current frame in a preceding modulo, and storing assembled frame in said memory (62),
means (52) for deciding a frame for transmission according to a request number in the area (D) of a request frame from a receiver side, where a request frame within a predetermined round trip delay time is disregarded,
means (66) for filling said fourth area (E) with an error detection code, and transmitting an assembled frame to a receiver side,
a receiver side comprises;
means (40) for detecting a transmission error in a frame by using an error code in said fourth area (E),
a receive buffer memory (46) storing receive frames by at least a modulo of frames,
means (54) for deciding a request frame to a transmit side with a request frame number (D) which is next frame of the latest received frame defined in the area (C) in case of no transmission error, or a frame which an error is detected,
means (64) for filling said area (D) with a request frame number according to the decision by said means (54), and transmitting a request frame to a transmitter side, and
means (66) for transmitting an output of said means (64) to said transmitter side with filling an error detection code to said output of said means (64),
wherein the improvements comprise in that;
said receiver side comprises further comparison means (68) for comparing said part (B_n) in a first area (B) in a current received frame with corresponding part (B_n) in corresponding frame having the same frame number as that of said current received frame in a preceding modulo stored in said receive buffer memory (46), and deciding whether to disregard said current received frame when former coincides with latter since said current received frame has previously been received, or to take said current received frame and update content of said receive buffer memory (46) with said current received frame when former differs from latter since said current received frame is a newly received frame.

2. System for re-transmission according to claim 1, wherein;

said user data has a plurality of words each of which has a plurality of bits, so that said first area has capacity of n number of words, where n is an integer larger than 2,
said part of said first area is last word area in said first area,
said fifth area (A) for carries a number showing how many words of a user data said first area carries, and
said transmitter side comprises further means for transferring last word of a user data to a succeeding frame, filling n-1 in said fifth area, and insert in a last word area (B_n) of said first area (B) a data which differs at least one bit from a data in a last word area of a first area in the frame of the same frame number as that of the current frame in a preceding modulo, when amount of said user data is equal to or exceeds capacity of said first area, and n'th word of the current frame coincides with n'th word in the frame of the same frame number as that of the current frame in a preceding modulo.

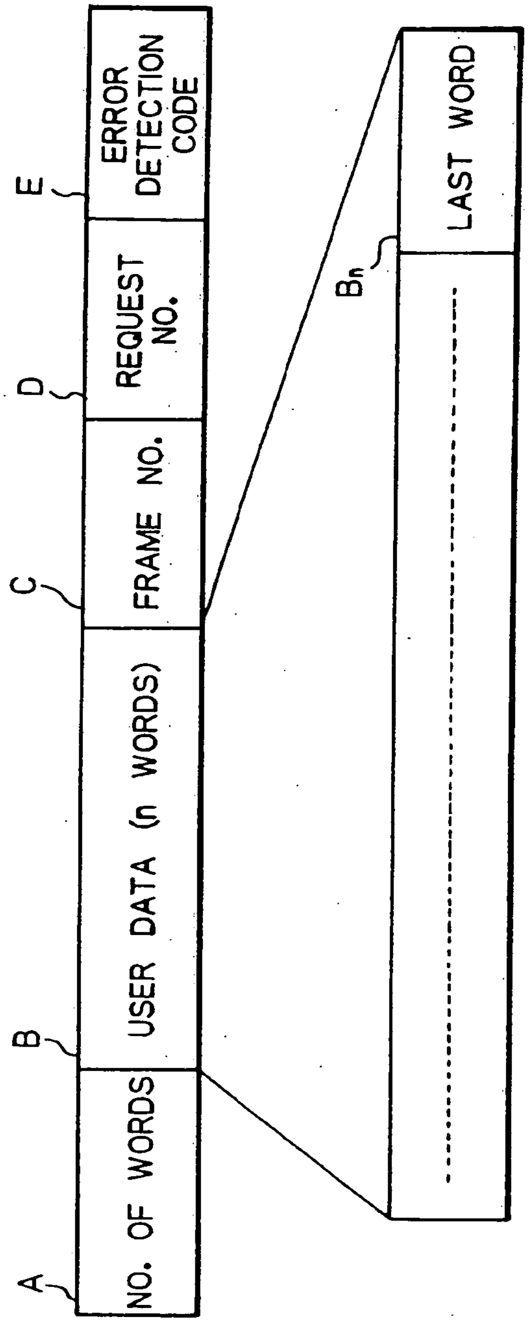
3. System for re-transmission according to claim 2, wherein said word has 8 bits.

4. Method for re-transmission through an Selective Repeat system in a data communication for a data frame having a forward channel and a feedback channel, having a transmitter side and a receiver side,

said data frame comprising at least;
a first area (B) for carrying a user data,
a second area (C) for carrying a frame number of each frame, said frame number being incremented one by one for each frame with a pre-

determined modulo M,
a third area (D) for carrying a repeat request number which is forwarded from a receiver side to a transmitter side requesting transmission of a frame, and
a fourth area (E) for carrying an error detection code for a frame,
a fifth area (A) for carrying a number which shows how much user data is filled in said first area (B),
said transmitter side comprising at least the steps of; assembling said first area (B), said fifth area (A) and second second area (C) of said frame,
storing assembled frame in a transmit buffer memory (62),
deciding a frame to be transmitted according to content in said third area (D) of a request frame from a receiver side, and disregarding said request frame in a predetermined round-trip-delay (RTF);
reading the decided frame out of said memory (62) with filling an error detection code of a frame in said fourth area (E) and transmitting the frame to a receiver side
said receiver side comprising at least the steps of;
detecting a transmission error in a received frame by using an error detection code in said fourth area (E),
storing said received frame in a receive data buffer memory (46) by at least a modulo number of frames,
taking said received frame out of said memory (46) to provide a received user data,
transmitting a request frame to a transmitter side with filling a request frame number in said second area (C) according to a number in said third area (D) of a received frame,
wherein the improvements comprise in the steps;
said assembling step in said transmitter side further comprising the steps of modifying a part (B_n) in said first area (B) so that said part (B_n) differs from the corresponding part in a frame having the same frame number as that of a current frame in a preceding modulo, and
said receiver side further comprising the steps of comparing said part (B_n) in a first area (B) in a current received frame with corresponding part (B_n) in a corresponding frame having the same frame number as that of said current received frame in a preceding modulo stored in said receive buffer memory (46), and deciding whether to disregard said current received frame when former coincides with latter since the current received frame has previously been received, or to take said current received frame and update content of said receive buffer memory (46) with said current received frame when former differs from latter since the current received frame is a newly received frame.

Fig. 1


A
NO. OF WORDS
B
USER DATA (n WORDS)
C
FRAME NO.
D
REQUEST NO.
E
ERROR DETECTION CODE
Bn
LAST WORD

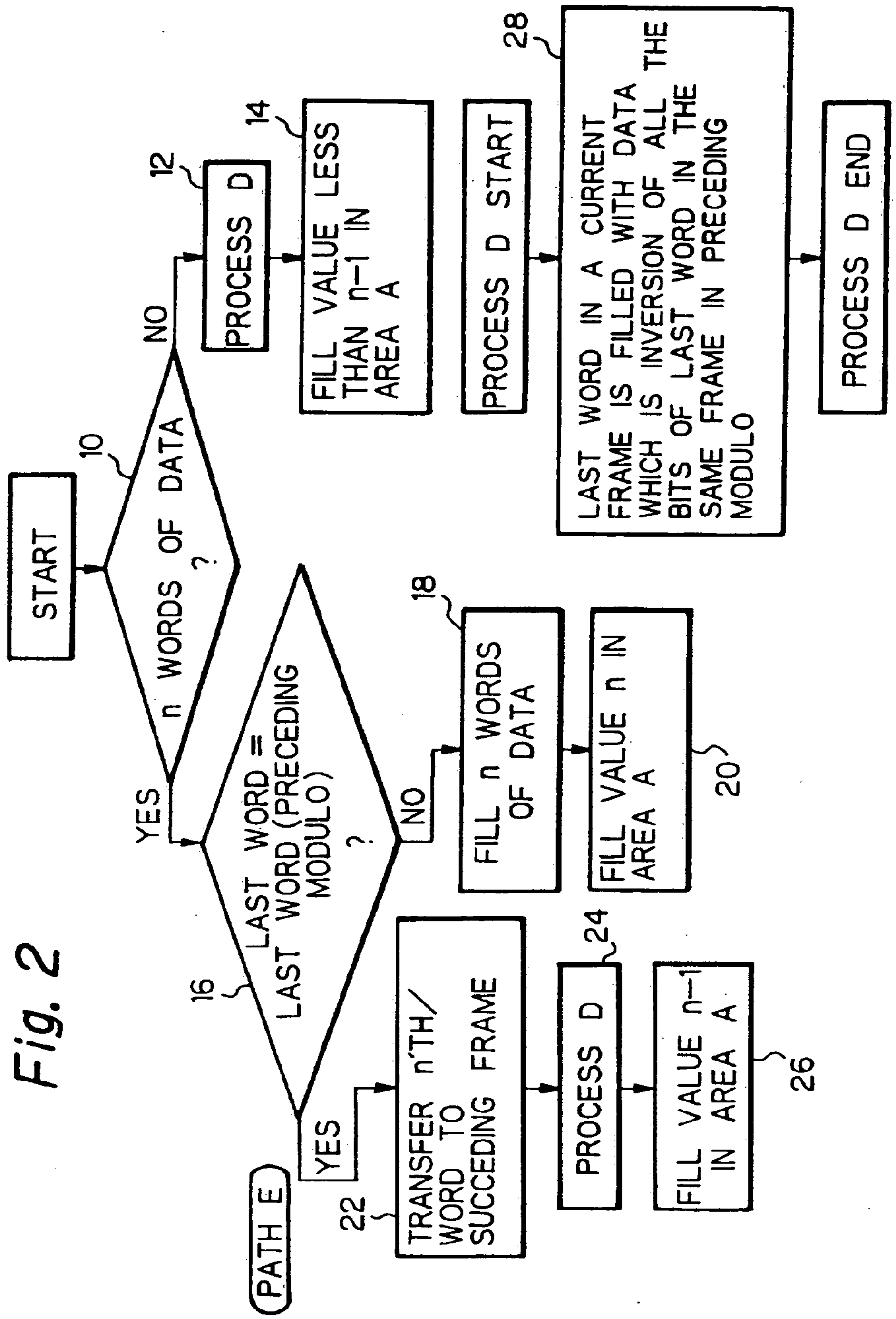

START
10
n WORDS OF DATA ?
YES
NO
12
PROCESS D
14
FILL VALUE LESS THAN n−1 IN AREA A
16
LAST WORD = LAST WORD (PRECEDING MODULO) ?
NO
18
FILL n WORDS OF DATA
20
FILL VALUE n IN AREA A
YES
PATH E
22
TRANSFER n'TH/ WORD TO SUCCEDING FRAME
24
PROCESS D
26
FILL VALUE n−1 IN AREA A
PROCESS D START
28
LAST WORD IN A CURRENT FRAME IS FILLED WITH DATA WHICH IS INVERSION OF ALL THE BITS OF LAST WORD IN THE SAME FRAME IN PRECEDING MODULO
PROCESS D END

Fig. 2

Fig. 3

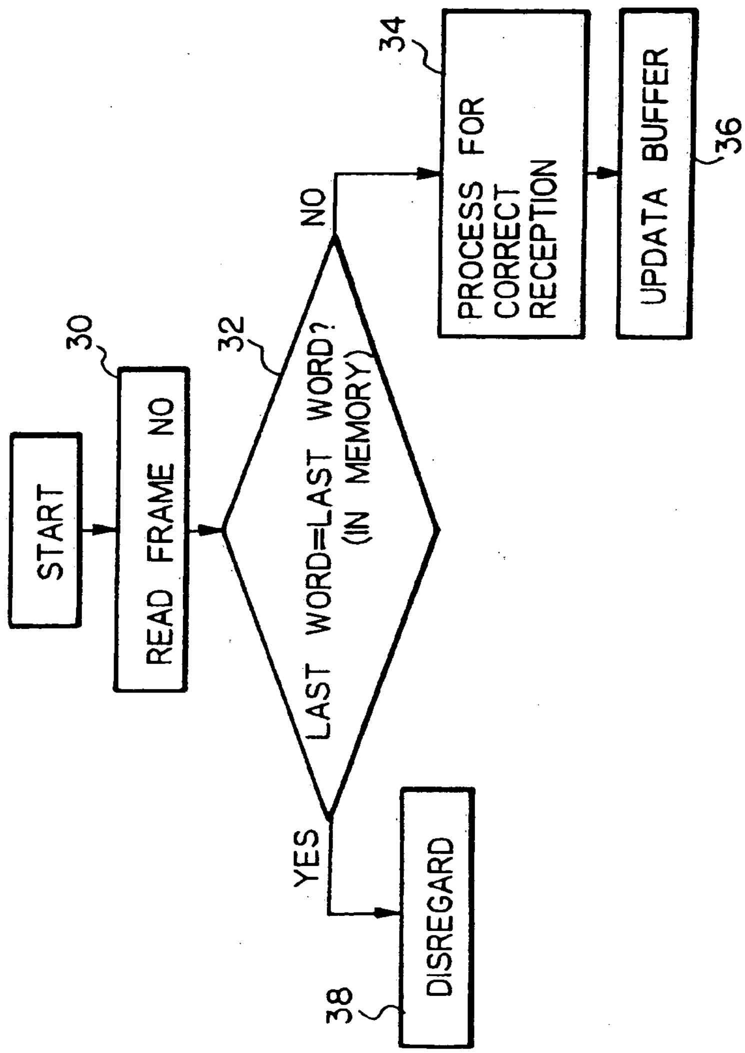

START
READ FRAME NO
30
LAST WORD=LAST WORD?
(IN MEMORY)
32
NO
PROCESS FOR
CORRECT
RECEPTION
34
UPDATA BUFFER
36
YES
DISREGARD
38

Fig. 4

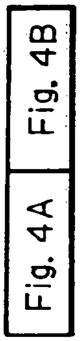


Fig. 4A
Fig. 4B

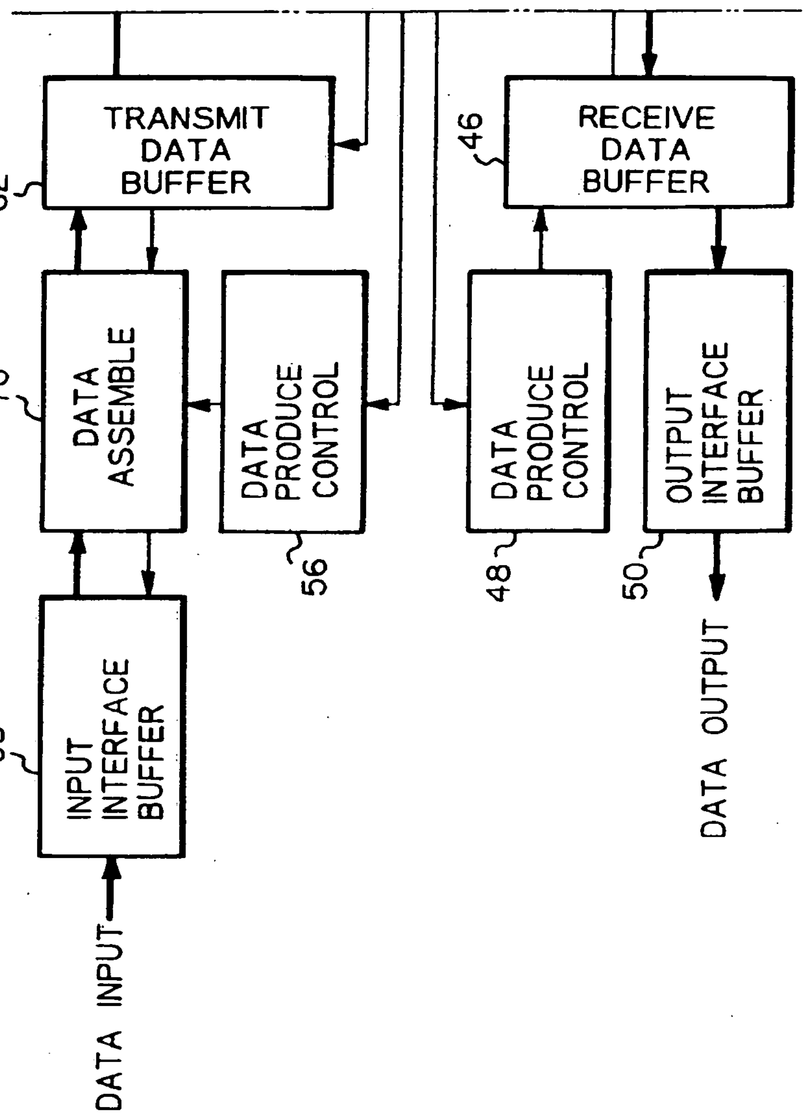

TRANSMIT DATA BUFFER
62
RECEIVE DATA BUFFER
46
DATA ASSEMBLE
70
DATA PRODUCE CONTROL
56
DATA PRODUCE CONTROL
48
OUTPUT INTERFACE BUFFER
50
INPUT INTERFACE BUFFER
58
DATA INPUT
DATA OUTPUT

Fig. 4A

Fig. 4B

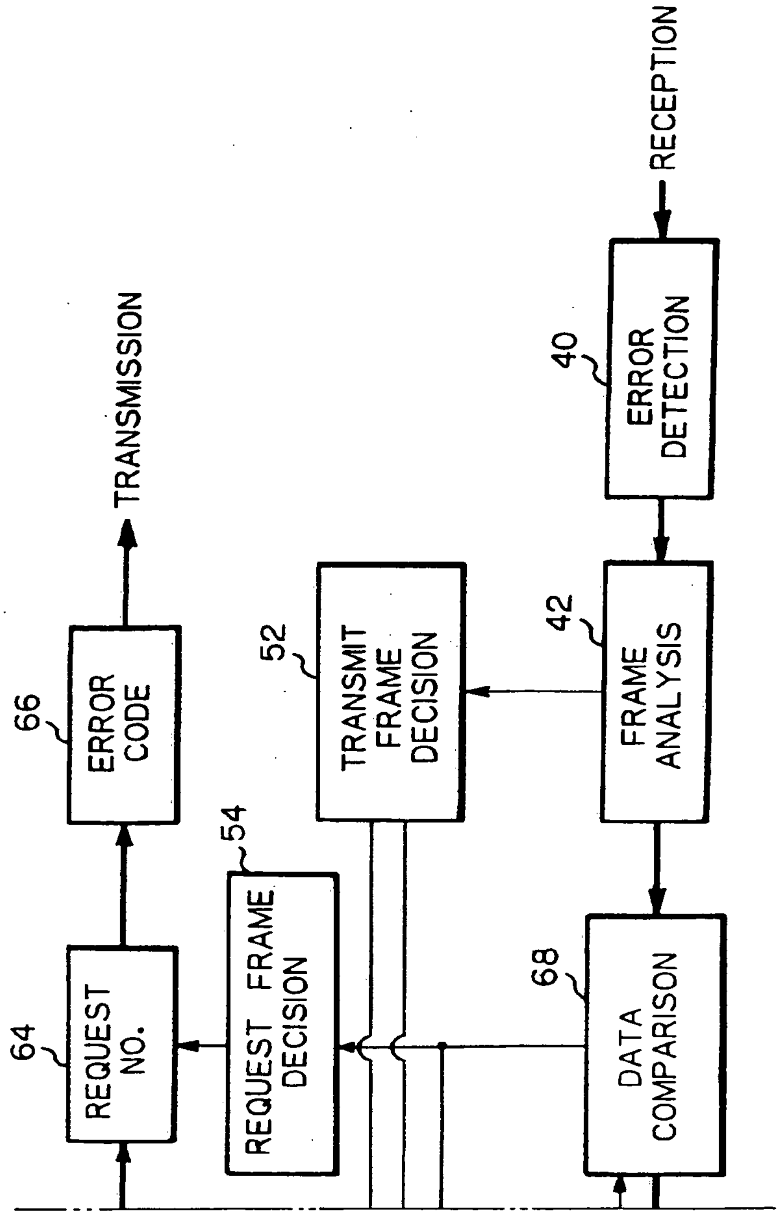

TRANSMISSION
66
ERROR CODE
64
REQUEST NO.
54
REQUEST FRAME DECISION
52
TRANSMIT FRAME DECISION
RECEPTION
40
ERROR DETECTION
42
FRAME ANALYSIS
68
DATA COMPARISON

Fig. 5

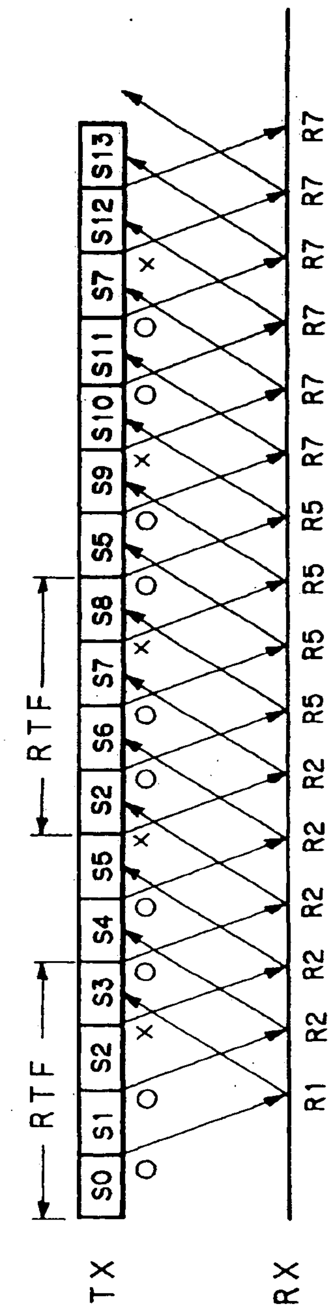

TX
RX
RTF
RTF
S0
S1
S2
S3
S4
S5
S2
S6
S7
S8
S5
S9
S10
S11
S7
S12
S13
R1
R2
R2
R2
R2
R2
R5
R5
R5
R5
R7
R7
R7
R7
R7
R7

Fig. 6

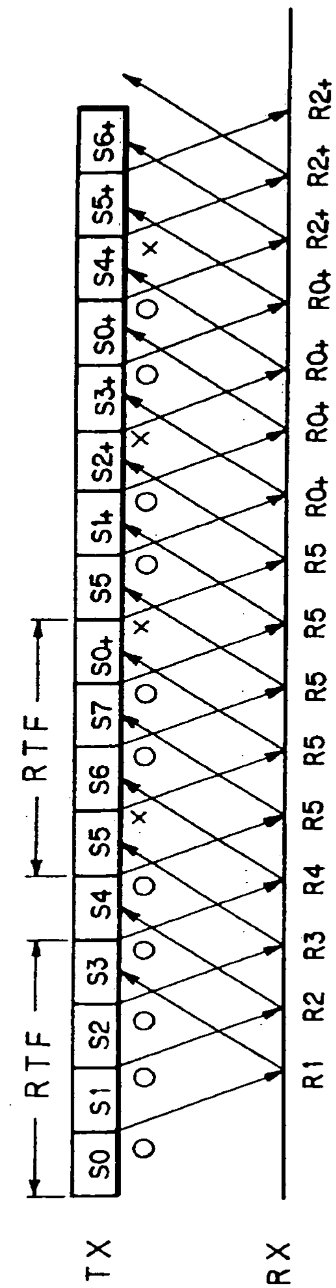

TX
RX
RTF
RTF
S0
S1
S2
S3
S4
S5
S6
S7
S0+
S5
S1+
S2+
S3+
S0+
S4+
S5+
S6+
R1
R2
R3
R4
R5
R5
R5
R5
R5
R0+
R0+
R0+
R0+
R2+
R2+
R2+

Fig. 7

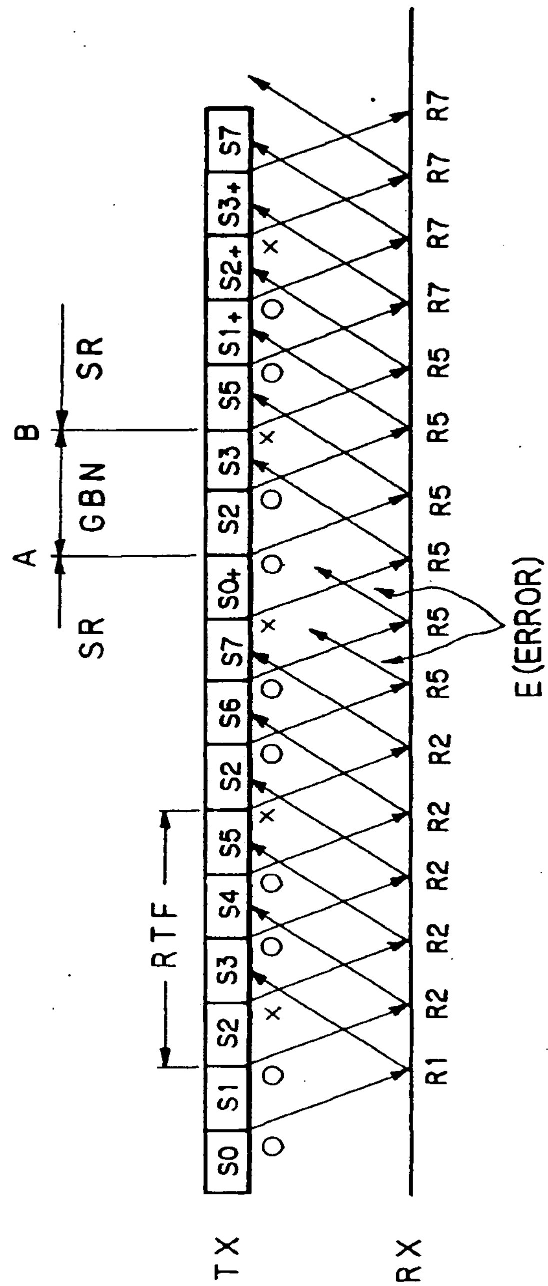

TX
RX
S0
S1
S2
S3
S4
S5
S2
S6
S7
S0+
S2
S3
S5
S1+
S2+
S3+
S7
R1
R2
R2
R2
R2
R2
R2
R5
R5
R5
R5
R5
R5
R7
R7
R7
R7
RTF
SR
A
GBN
B
SR
E (ERROR)

Fig. 8 PRIOR ART

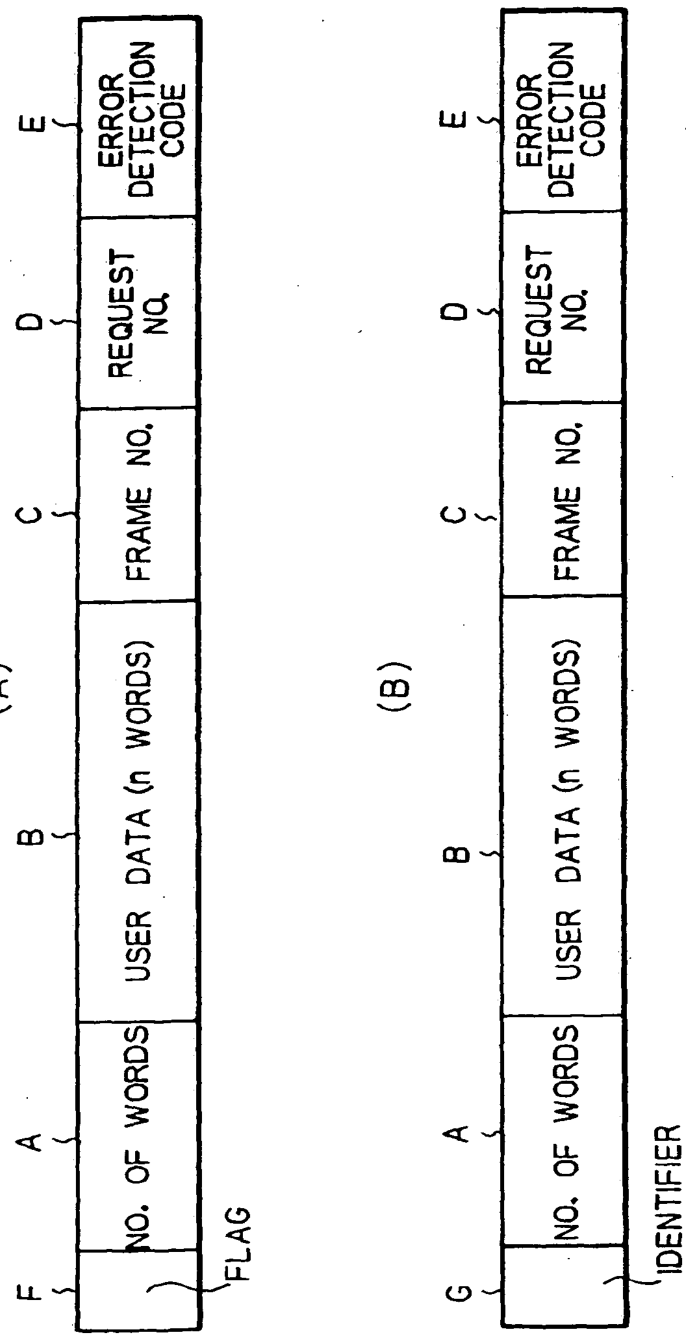


Fig. 9

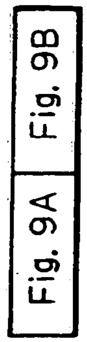


Fig. 9A
Fig. 9B

Fig. 9A

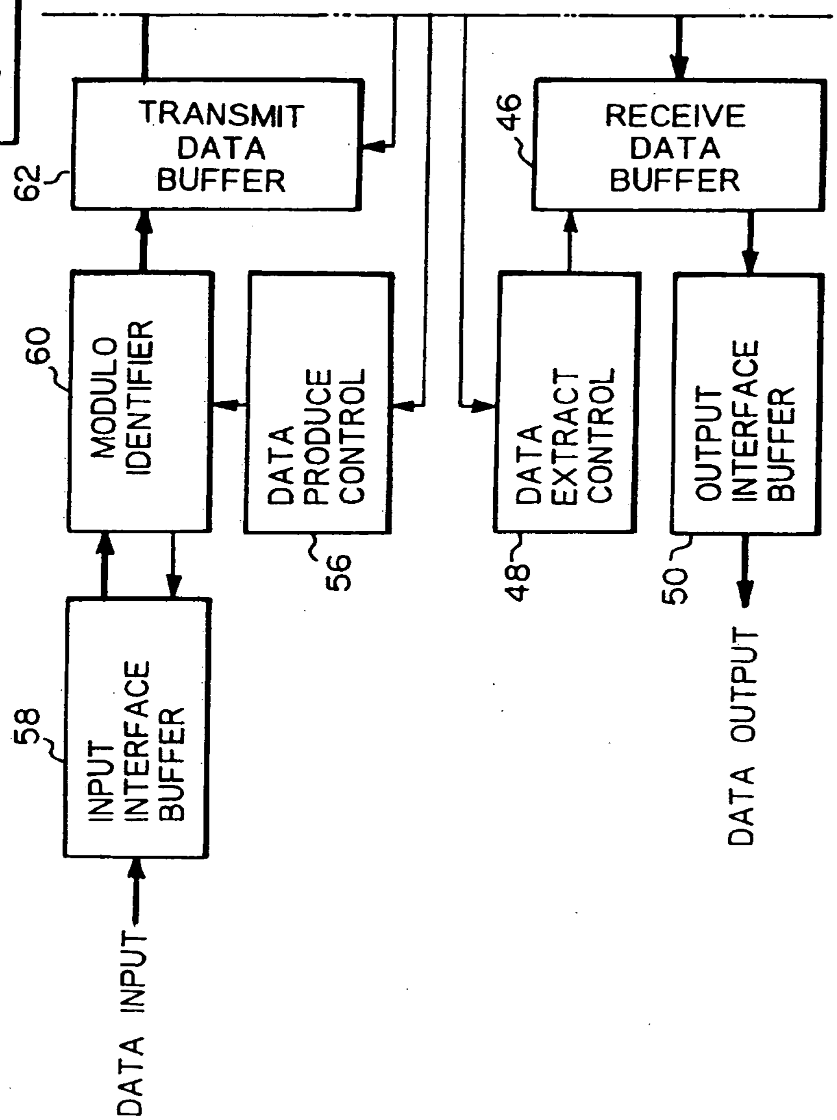

TRANSMIT DATA BUFFER
62
RECEIVE DATA BUFFER
46
MODULO IDENTIFIER
60
DATA PRODUCE CONTROL
56
DATA EXTRACT CONTROL
48
OUTPUT INTERFACE BUFFER
50
INPUT INTERFACE BUFFER
58
DATA INPUT
DATA OUTPUT

Fig. 9B

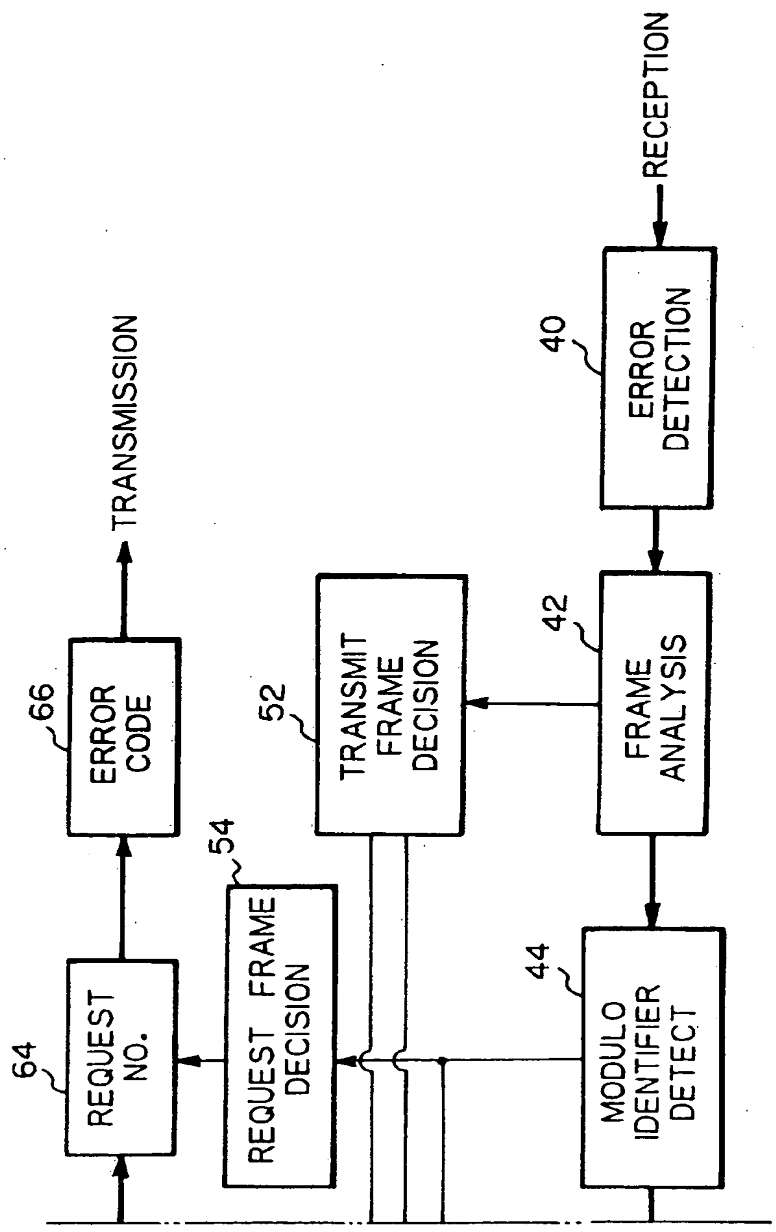
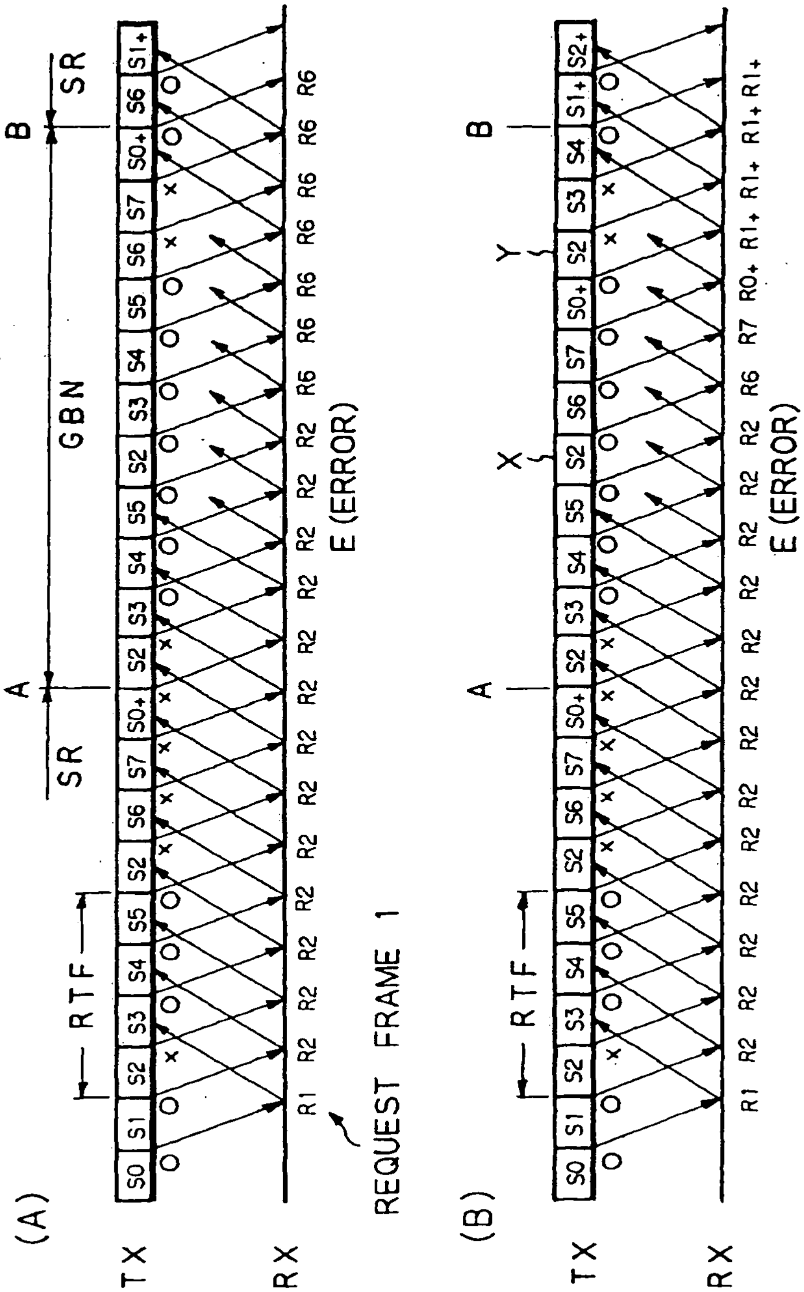

RECEPTION
40
ERROR DETECTION
42
FRAME ANALYSIS
44
MODULO IDENTIFIER DETECT
52
TRANSMIT FRAME DECISION
54
REQUEST FRAME DECISION
64
REQUEST NO.
66
ERROR CODE
TRANSMISSION

Fig. 10


(A)
TX
RX
S0 S1 S2 S3 S4 S5 S2 S6 S7 S0+ S2 S3 S4 S5 S2 S3 S4 S5 S6 S7 S0+ S6 S1+
RTF
SR
A
GBN
B
SR
R1 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R6 R6 R6 R6 R6 R6 R6 R6
REQUEST FRAME 1
E (ERROR)
(B)
TX
RX
S0 S1 S2 S3 S4 S5 S2 S6 S7 S0+ S2 S3 S4 S5 S2 S6 S7 S0+ S2 S3 S4 S1+ S2+
RTF
A
X
Y
B
R1 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R6 R7 R0+ R1+ R1+ R1+ R1+ R1+
E (ERROR)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 95410116.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 6)
A	WO - A - 93/20 632 (BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY) * Page 1, line 3 - page 4, line 36; page 10, line 6 - page 13, line 19; fig. 1-4 * --	1,4	H 04 L 1/18 H 04 L 1/16
A	IEEE TRANSACTIONS ON COMMUNICATIONS, vol. COM-30, no. 3, March 1982 E.J. WELDON, Jr. "An Improved Selective-Repeat ARQ Strategy" pages 480-486 * Page 480, right-hand column, line 7 - page 482, left-hand column, line 51 * --	1,4	
A	IEEE TRANSACTIONS ON COMMUNICATIONS, vol. COM-23, no. 4, April 1975 A.R.K. SASTRY "Improving Automatic Repeat-Request (ARC) Performance on Satellite Channels Under High Error Rate Conditions" pages 436-439 * Page 436, left-hand column, lines 14-45; page 439, left-hand column, lines 10-22 * --	1,4	TECHNICAL FIELDS SEARCHED (Int. Cl. 6) H 04 L
A	EP - A - 0 430 125 (ALCATEL) * Page 2, line 1 - page 5, line 18; fig. * ----	1,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	19-12-1995	HAJOS

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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(54) **System for re-transmission in data communication**

System für Sendewiederholung in der Datenkommunikation

Système de retransmission dans la communication de données

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(56) References cited:
EP-A- 0 430 125 **WO-A-93/20632**

- **IEEE TRANSACTIONS ON COMMUNICATIONS, vol. COM-30, no. 3, March 1982 E.J. WELDON, Jr. "An Improved Selective-Repeat ARQ Strategy" pages 480-486**
- **IEEE TRANSACTIONS ON COMMUNICATIONS, vol. COM-23, no. 4, April 1975 A.R.K. SASTRY "Improving Automatic Repeat-Request (ARC) Performance on Satel- lite Channels Under High Error Rate Conditions" pages 436-439**

EP 0 707 394 B1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an ARQ system, or a system for autmatic request (or repeat) transmission in data communication system, in particular, relates to such a system which provides error-free transmission with high efficiency in a mobile communication system which has mainly burst errors.

[0002] A prior ARQ system in data communication system which has a feedback channel is a selective repeat (SR) system.

[0003] WO-A9320632 and IEEE TRANSACTIONS ON COMMUNICATIONS, vol. COM-30, no. 3, March 1982 E.J. WELDON, Jr., pages 480-486, disclose a Selective-Repeat ARQ system.

[0004] Fig.5 shows the operational time chart of an ideal SR system, in which it is assumed that a receiver has ideally infinite amount of buffer memories. In Fig.5, symbol S_i (i is integer) shows a frame number which is assigned to each data frame in a transmitter side, and R_i shows a frame number which is returned from a receiver side to a transmitter side through a feedback channel. A transmitter side, upon receipt of a frame number R_i, recognizes that a receiver side receives correctly a frame R_{i-1}, and a receiver side requests a transmitter side to send a next frame S_i. It is assumed in Fig. 5 for the sake of simplicity of explanation that no error occurs in a feedback channel. In Fig.5, the symbol O shows that a frame is received correctly, and the symbol X shows a frame is not received correctly.

[0005] The SR ARQ system has the feature that a transmitter side repeats the transmission of an only frame which is requested by a receiver side. Further, a transmitter side disregards a repeat request R_i which is received by the transmitter side within round-trip-delay (RTF), since it is much possible that a correct frame which is repeated to a receiver side has not been received yet by a receiver side. The value of RTF is predetermined in each system in a design stage of a system, considering delay time between a transmitter side and a receiver side. In the embodiment of Fig.5, the value of RTF is time for four frames.

[0006] In Fig.5, the receiver side (RX) receives the frame S_0 correctly, and therefore, returns a request frame R_1, requesting to send the frame S_1. The frame S_1 is also received correctly. However, the frame S_2 is not received correctly, and therefore, the request frame R_2 is returned to the transmitter side. The request frame R_2 is sent to the transmitter side until the frame S_2 is received correctly. The transmitter side recognizes R_2 after the frame S_5 is transmitted, and so, the frame S_2 is re-transmitted after S_5, and the frames S_6, S_7 and S_8 follow. Although the transmitter side receives the request frame R_2 at the timing of S_6 and S_7 after it retransmits S_2, those request frames are disregarded since it is within RTF time since S_2 is re-transmitted. The re-transmitted S_2 is received correctly. So, the receiver side requests R_5 since S_5 is not received correctly, and so, the transmitter side re-transmits the frame S_5 after the frame S_8.

[0007] The SR ARQ system has disadvantage that each of a transmitter side and a receiver side must install infinite amount of buffer memory, and/or infinite numbers for data frames, in order to assure the correct sequence of receive frames in a receiver side, since a frame must be stored in a transmitter side and a receiver side until correct reception of each frame is acknowledged in a transmitter side, although the SR ARQ system has advantage that the transmission efficiency is excellent.

[0008] However, in an actual transmitter and an actual receiver, amount of buffer memory, and/or number of frames is not infinite, but is finite repeating with modulo M. Therefore, it is absolutely impossible to implement an ideal ARQ system shown in Fig.5.

[0009] Fig.6 shows the operational time chart of another prior SR system, in which the modulo is 8, in which S_i and R_i show number of a frame in a transmitter side and a receiver side in a first modulo turn, respectively, and S_i+ and R_i+ show number of a frame in a transmitter side and a receiver side in a succeeding modulo turn, respectively. It is noted in Fig.6 that a frame number (i of S_i, R_i, S_i+, R_i+) is one of 0 through 7, because a value of modulo is 8.

[0010] Theoretically speaking, the maximum frames which are allowed to a transmitter side to send with no acknowledge from a receiver side in an SR ARQ system is (modulo - 1) frames, on the condition that the sequence of frames in a receiver side is kept. That number (modulo - 1) is called an outstanding number. When the modulo is 8, the outstanding number is 7.

[0011] It should be noted that a receiver side can not differentiate a frame S_i and a frame S_i+ in a receiver side since those frames have the same frame number (i) as each other, although they are differentiated in the figure for the sake of easy explanation. If a transmitter side sends frames more than the outstanding number, a receiver side can not identify two frames which have the same frame number as each other, which modulo each of the frames belongs, and therefore, the sequence of the frames in a receiver side is not kept.

[0012] In wired data communication systems, the number of modulo is designed to be large enough in a system design so that no frame having the frame number close to the outstanding number is transmitted, considering transmission quality. On the other hand, in radio communication systems, in particular, in a mobile communication system, it is impossible to have large modulo, if we consider an intermittent breakdown of a communication system due to a channel switching and/or hand over, and power consumption allowable for a portable terminal set.

[0013] One solution for the above problem is the combination of an SR ARQ system and a GBN (Go-back-N)

ARQ system which has less transmission efficiency than an SR ARQ system but has no problem of differentiation of modulos.

[0014] Fig.7 shows the operational time chart of a prior system which is the combination of an SR ARQ system, and a GBN ARQ system. The prior GBN system has the feature that a transmitter side re-transmits all the frames between the first frame that a receiver side request the re-transmission and the latest frame which the transmitter side has sent. In Fig.7, a transmitter side has transmitted the frame S_0+ at time A, where the acknowledgement of S_1 is acknowleged by the reception of R_2, but no acknowledgement of S_4 is acknowledged, since the feedback channel for R_5 was in error. The number of frames which can be transmitted at time A is $(2+6)_{modulo\ 8}=0$. This means that no further frame must not be sent since 6 frames (S_3, S_4, S_5, S_6, S_7, S_0+) have been sent after S_2 which is the oldest frame that is not acknowledged. Therefore, the transmitter system is switched to the GBN ARQ system from the SR ARQ system, since if the transmitter side sends more frames, it exceeds outstanding number (=7). Next, during the transmission operation under the GBN ARQ system, the number of frames which can be transmitted at time B is $(5+6)_{modulo\ 8}=3$, where the frame S_5 is the oldest frame which is not acknowledged, and since that number (=3) is equal to or larger than 1, the transmission system is switched to the SR ARQ system, which is more efficient than the GBN ARQ system.

[0015] The prior system for the operation of Fig.7 has the disadvantage that a frame structure must include at least one bit for indicating a flag which one of an SR system and a GBN system is used currently, and the presence of that flag decreases the transmission efficiency, and the system design of a communication system for adding that flag in a current communication system is complicated.

[0016] By the way, if we wish to operate only an SR ARQ system with no switching to a GBN ARQ system, a receiver side must differentiate two frames which have the same frame number as each other and appear for each modulo turn, for at least two modulo turns.

[0017] So, the other prior art is to have a modulo identifier in a frame structure so that which modulo a frame belongs.

[0018] Fig.8 shows two examples of prior arts, which have a SR/GBN flag or a modulo identifier in a frame structure. In the figure, the numeral A is an area showing amount of words of a user data in the frame, B is an area containing a user data for communication, C is a frame number filled in a transmitter side, repeating the modulo M, D shows a frame number which a receiver side requests the transmission, E is a test bit (for instance a CRC bit) which is filled in a transmitter side so that a transmission error is detected in a receiver side. The symbol F is a flag showing the current operation system which is one of an SR ARQ system, and a GBN ARQ system, used in the embodiment of Fig.7, and the symbol G is a modulo identifier showing which modulo a flame belongs. The area D for showing a request frame is included in the frame structure, as it is assumed that the feedback channel uses the same frame structure as the forward frame structure.

[0019] Fig.9 shows a block diagram of a prior ARQ system which has a modulo identifier of Fig.8B, including both a transmitter side and a receiver side. In the figure, in a receiver side, a received signal is applied to an error detector 40, which tests if a transmission error occurs by checking an error detecting code in the area E which is filled in a transmitter side. When no transmission error is detected, the received signal is applied to a frame analysis circuit 42, and when a transmission error is detected, the received signal is disregarded. The frame analysis circuit 42 takes a frame number of the received frame, and sends said number to the transmit frame decision circuit 52. At the same time, the frame analysis circuit 42 forwards the whole received frame to the modulo identifier detector 44, which takes the frame number C and the modulo identifier G in the frame structure, and decides whether the current frame which is now received is a newly received frame or a re-transmission frame which has been received before. When it is a re-transmission frame, it is disregarded, and when it is a newly received frame, it is applied to a receiver data buffer 46, and simultaneously, the modulo identifier detector 44 sends the frame number which is acknowledged the safe receipt to the request frame decision circuit 54 and the receive data extract control circuit 48.

[0020] As it is an SR ARQ system in Fig.9, no sequence of received frames is guaranteed in a receiver side. Therefore, the received data extract control circuit 48 controls the transfer of data from the data buffer 46 to the output interface buffer 50 so that the sequence of receive data is kept.

[0021] The transmit frame decision circuit 52 decides a next frame which is to be sent based upon the requested frame number D, and instructs the transmit data buffer 62 the next frame to be sent. Simultaneously, the circuit 52 instructs the transmit data produce control circuit 56 the frame number which is to be updated by a new data frame. The request frame decision circuit 54 decides the request frame based upon the frame number C of the received frame from the receiver side, and instructs the request number assign circuit 64 the request frame. The transmit data produce control circuit 56 instructs the modulo identifier assign circuit 60 the frame numbers which carry new data frames. The modulo identifier assign circuit 60 assigns the modulo identifier to the output data of the input interface buffer 58 so that a frame is recognized which modulo it belongs, and the modulo identifier together with the user data are stored in the transmit data buffer 62. The transmit data buffer 62 sends the request number assign circuit 64 a data frame based upon the instruction by the transmit frame decision circuit 52.

[0022] The request number assign circuit 64 assigns

the value which is sent from the request frame decision circuit 54 into the request frame number area D in the frame structure, and sends the frame to the error detection code assign circuit 66. The error detection code assign circuit 66 fills an error detection code (for instance, a parity bit, or a CRC (cyclic redundancy check) code), and the whole frame is forwarded to a communication line.

[0023] However, a prior ARQ system, the combination of an SR ARQ system and a GBN ARQ system, and/or an SR ARQ system having a modulo identifier have the disadvantages as follows.

[0024] In case of combination of an SR ARQ system and a GBN ARQ system, it switches often to a GBN ARQ system when many burst errors occur because of deep fading in mobile communication system, and that switching would cause the undesirable decrease of throughput. Further, as a flag for indicating whether it is an SR ARQ system, or a GBN ARQ system must be included in a frame structure, the amount of data area available to a user is decreased. Further, since two systems, an SR ARQ system and a GBN ARQ system are operated, the structure of an apparatus is complicated.

[0025] Fig.10 shows the operational time chart of a prior ARQ system, in which Fig.10A shows the time chart in case of the combination of an SR ARQ system and a GBN ARQ system, and Fig.10B shows the case of the modulo identifier type.

[0026] It is assumed that the modulo is 8 both in Fig. 10A and Fig.10B.

[0027] In comparing Fig.10A with Fig.10B, a receiver in Fig.10A acknowledges the correct receipt of the frame 5 at time B (frame 6 is requested by R_6) because of the switching to a GBN ARQ system due to continuous errors, while in Fig.10B a receiver acknowledges the correct receipt of the frame 0+ at time B. Therefore, it appears that the modulo identifier type of Fig.10B is better than the case of Fig.10A.

[0028] However, the modulo identifier type of Fig.10B has the disadvantage that it must have an identifier for indicating a modulo turn in a frame structure, and the presence of said identifier decreases a throughput. Further, as a control in a hardware is carried out for a byte which has 8 bits, the presence of a modulo identifier occupies at least 8 bits, although an identifier itself has only one bit.

SUMMARY OF THE INVENTION

[0029] The object of the present invention is to provide a new and improved ARQ system by overcoming the disadvantages and limitations of a prior ARQ system.

[0030] It is also an object of the present invention to provide an ARQ system which operates under an SR ARQ system with no switching to a GBN ARQ system.

[0031] It is also an object of the present invention to provide an ARQ system which operates under an SR ARQ system with infinite number of frames, no modulo identifier, while keeping the sequence of receive frames.

[0032] The above and other objects are attained by system for re-transmission through an Selective Repeat system in a data communication for a data frame having a forward channel and a feedback channel, having a transmitter side and a receiver side comprising; said data frame comprises at least; a first area (B) for carrying a user data, a second area (C) for carrying a frame number of each frame, said frame number being incremented one by one for each frame with a predetermined modulo M, a third area (D) for carrying a repeat request number which is forwarded from a receiver side to a transmitter side requesting transmission of a frame, and a fourth area (E) for carrying an error detection code for a frame, a fifth area (A) for carrying a number which shows how much user data is filled in said first area (B), said transmitter side comprises at least; a transmit buffer memory (62) storing said first area (B), said fifth area (A) and said second area (C) of said frame by at least a modulo number of frames, frame assemble means (70) for assembling a frame with a user data and modifying a part (B_n) in said first area (B) so that said part (B_n) differs from the corresponding part in a frame having the same frame number as that of a current frame in a preceding modulo, and storing assembled frame in said memory (62), means (52) for deciding a frame for transmission according to a request number in the area (D) of a request frame from a receiver side, where a request frame within a predetermined round trip delay time is disregarded, means (66) for filling said fourth area (E) with an error detection code, and transmitting an assembled frame to a receiver side, a receiver side comprises; means (40) for detecting a transmission error in a frame by using an error code in said fourth area (E), a receive buffer memory (46) storing receive frames by at least a modulo of frames, means (54) for deciding a request frame to a transmit side with a request frame number (D) which is next frame of the latest received frame defined in the area (C) in case of no transmission error, or a frame which an error is detected, means (64) for filling said area (D) with a request frame number according to the decision by said means (54), and transmitting a request frame to a transmitter side, and means (66) for transmitting an output of said means (64) to said transmitter side with filling an error detection code to said output of said means (64), wherein the improvements comprise in that; said receiver side comprises further comparison means (68) for comparing said part (B_n) in a first area (B) in a current received frame with corresponding part (B_n) in corresponding frame having the same frame number as that of said current received frame in a preceding modulo stored in said receive buffer memory (46), and deciding whether to disregard said current received frame when former coincides with latter since said current received frame has previously been received, or to take said current received frame and update content of said receive buffer memory (46) with said current received frame when former differs from lat-

ter since said current received frame is a newly received frame.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The foregoing and other objects, features, and attendant advantages of the present invention will be appreciated as the same become better understood by means of the following description and accomanying drawings wherein;

Fig.1 is structure of a data frame according to the present invention,
Fig.2 shows an operational flow chart for assembling a data frame in a transmitter side, according to the present invention,
Fig.3 shows an operational flow chart in a receiver side, according to the present invention,
Fig.4 shows a block diagram of a re-transmission system in data communication according to the present invention,
Fig.5 shows an operational time chart of an ideal SR ARQ system,
Fig.6 shows an operational time chart in an actual SR ARQ system with the modulo number 8,
Fig.7 shows an operational time chart in a prior art which is the combination of an SR ARQ system and a GBN ARQ system,
Fig.8 shows two examples of a structure of a data frame in a prior art,
Fig.9 is a block diagram of a prior repeat request system for data communication, and
Fig.10 shows an operational time chart in a prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0034] The basic idea of the present invention is an improvement of an SR ARQ system with infinite modulo number, but with no modulo identifier. The function of a modulo identifier is provided by modifying a user data itself.

[0035] Fig.1 shows a structure of a data frame according to the present invention. The structure of Fig.1 is essentially the same as the structure of a prior SR ARQ system. In the figure, the symbol A is an area carrying a value how many words a user data area B carry, B is a user data area for carrying a user data to be communicated. The user data area B has capacity to keep n words of data (n is integer larger than 2), and the last word B_n in the data area B is used for special purpose in the present invention. The symbol C is a frame number area showing a frame number of a frame. The frame number repeats with the modulo M, so that the frame number is between 0 and M-1. The frame number is attached in a transmitter side. The symbol D is a request frame area, which is attached in a receiver side. When a transmission error is detected, it is a repeat request, and when no error is detected, it is a request of a next frame. When a transmitter side receives a request frame from a receiver side, and the content of the request frame area D is, for instance p, (p is in the range between 0 and M-1), the transmitter side recognizes that the frames up to p-1 have been received correctly, and the receiver side requests the frame of the frame number p. A receiver side may request a frame p either when the frames up to p-1 are received correctly, and requests a next frame p, or when there is a transmission error in a frame p. The symbol E is an error detection area for carrying an error detection code to detect a transmission error of a frame. The error detection code is for instance a parity bit, or a CRC code. It is assumed in Fig.1 that the same frame structure is used in a feedback channel from a receiver side to a transmitter side.

[0036] Fig.2 shows an operational flow chart for deciding the last word B_n in the user data area B in the frame structure in assembling a frame in a transmitter side. The last word B_n is used to find a modulo turn of a frame in the present invention.

[0037] In Fig.2, when the operation starts, the box 10 decides whether the user data for transmission has n words or not, where the value n is the maximum words included in an user data area B in each frame.

[0038] When the user words to be sent in a current frame are less than n, it goes to the box 12, which carries out the box 28. The box 28 fills the last word area B_n of the user data area B in a current frame with a data which is an inversion of all the bits of the last words B_n in a user data area B of a frame of the same frame number as said current frame in the preceding modulo. The box 14 fills the area A with a value which shows number of user words carried in the area B. Since the area B has capacity of n words, and the user words which should be sent are less than n words, the value in the area A is equal to or less than n-1.

[0039] When the box 10 recognizes that there are n words of user data for transmission, the box 16 tests whether all the bits in the last data word B_n in the frame of the same frame number as that of the current frame in the preceding modulo are completely the same as the bits in the last data word (n'th word) in the current frame in the current modulo. When the former (all the bits in the last data word in the frame of the same frame number in the preceding modulo) are completely the same as the latter (all the bits in the last data word in the current frame in the current modulo), the control goes to the path E, and the box 22 transfers the last word (n'th word) to the succeeding frame, in other words, the current frame carries n-1 words and the last word (n'th word) is transmitted in the next frame. Then, the box 24 carries out the box 28 in which the last word B_n in the user data area B in the current frame is filled with a data which is the inversion of the last word B_n in the user data area B of a frame of the same frame number as that of the current frame, in the preceding modulo. The box 26 carries out to fill the area A with a

value n-1, since n-1 user words are kept in the area B.

[0040] When the box 16 recognizes that all the bits in the last data word B_n in the user data area B of the current frame are not the same as the last data word B_n in the user data area B of a frame of the same frame number as that of the current frame, in the preceding modulo, the box 18 is carried out so that all the n data words are inserted in the user data area B. And, the box 20 fills the area A with value n.

[0041] In the above operation, it should be appreciated that the last word B_n in the user data area B in the corresponding frame in a preceding modulo does not completely coincide with the last word B_n in the user data area B in the current frame in the current modulo. This feature is used in a receiver side to differentiate a frame in another modulo turn, merely by comparing the last word B_n in a current frame with the last word B_n in the corresponding frame which has the same frame number in a preceding modulo.

[0042] In Fig.2, when the path E occurs, the last word in the user data area B is used only for differentiating modulos. However, the probability of the path E is very small, and in theoretical analysis, it is less than 0.4 % provided that each word has 1 byte with bits (8 bits).

[0043] Fig.3 shows the operational flow chart for differentiating modulo in a receiver side according to the present invention. When it starts, the box 30 reads a frame number of a frame in the area C. Then, the box 32 compares the last word B_n in the user data area B of the corresponding frame in a receive buffer 46 (which stores frames in a preceding modulo), with the last word B_n in the data area B in the current frame in the current modulo. When they coincide with each other, it means that the current frame is the re-transmitted frame which is already received correctly, and the current frame is disregarded.

[0044] When they do not coincide with each other, the box 34 processes the current frame as the correct frame, and the box 36 updates the content of the current frame area in the receive buffer 46 with the current received frame.

[0045] It should be appreciated that a receiver side may differentiate a modulo turn merely by comparing the last word in a user data area in a current frame with the last word in the corresponding frame which has the same frame number in a preceding modulo, and may determine whether a frame is re-transmitted, or it is a newly transmitted frame. Also, it should be appreciated that to keep a prior SR protocol, the buffer memory 62 and the buffer memory 46 must have the capacity enough to store a modulo number of frames (modulo number M is for instance M=8). So, it should be appreciated that the extra buffer memories are not needed for realizing the present invention.

[0046] The operational time chart of the present invention is the same as that of Fig.10B for a prior modulo identifier type.

[0047] In Fig.10B, the transmitter side sends frames S_0 through S_5, and since S_2 is in error and receives a request frame R_2 which requests to send S_2, the transmitter side sends S_2 after S_5, then, sends S_6, S_7, and S_0+, where S_0+ is a frame of frame number 0 in a succeeding modulo. However, since S_2 is again in error, it is re-transmitted again after S_0+. Then, S_3, S_4 and S_5 are sent. Those frames S_2, S_3 and S_4 are sent although they have been sent correctly, since the receiver side returns a request frame R_2, but does not acknowledge the safe receipt of S_3, S_4 and S_5. However, as S_2 is still in error, S_2 is re-transmitted again after S_5. And, S_6, S_7 and S_0+ are sent. That frame S_2 is received correctly with no error, and therefore, the receiver side stops to return a request frame R_2 which requests S_2 and return a request frame R_6 requesting S_6. However, since that request frame R_6 is not received by the transmitter side because of an error, the transmitter side does not recognize that S_2 is received correctly, and sends S_2 again after S_0+.

[0048] At that point, the receiver side would confuse whether the received frame S_2 is S_2 (=Y) or S_2+ as it has already received S_0+. According to the present invention, a receiver side carries out the operation in Fig. 3, and found that the last word of the current frame S_2 (=X) is the same as the last word of the corresponding frame (Y) stored in the memory 46, and recognizes that the current S_2 (=X) is a re-transmitted frame, and should be disregarded.

[0049] In the present invention, the number of user words to be able to transmit in a frame is decreased to n-1 words although a frame has capacity to transmit n words, nevertheless, the present invention is useful since the probability of the above occasion (path E in Fig.3) is very small. In a prior art, a frame structure must have one bit for differentiating a modulo, or an SR system and a GBN system, and further, the presence of one bit means that it must have one word which has 8 bits.

[0050] Fig.4 shows a block diagram of the present ARQ system. The feature of Fig.4 as compared with Fig. 9 is that a modulo identifier assign circuit 60 in Fig.9 is replaced by a transmit frame assembling circuit 70, and that a modulo identifier detector 44 in Fig.9 is replaced by a data comparator 68. Also, in Fig.4, a signal line from a transmit data buffer 62 to a transmit frame assembling circuit 70, and a signal line from a receive data buffer 46 to a data comparator 68 are provided. The operation of the transmit frame assembling circuit 70 is shown in Fig.2, and the operation of the data comparator 68 is shown in Fig.3.

[0051] As mentioned above in detail, the present invention provides error-free transmission with high transmission efficiency in a communication circuit for a mobile communication having many burst errors, with simple structure and with no additional bit in a frame structure.

[0052] Some modification is of course possible to those skilled in the art. For instance, the last word B_n for comparison is not restricted to the last word, but any por-

tion of a user data area may be used instead of the last word.

[0053] From the foregoing it will now be apparent that a new and improved ARQ system has been found. It should be understood of course that the embodiments disclosed are merely illustrative and are not intended to limit the scope of the invention. Reference should be made to the appended claims, rather than the specification as indicating the scope of the invention.

Claims

1. System for re-transmission through an Selective Repeat system in a data communication for a data frame having a forward channel and a feedback channel; having a transmitter side and a receiver side comprising;

   said data frame comprises at least;
   a first area (B) for carrying a user data,
   a second area (C) for carrying a frame number of each frame, said frame number being incremented one by one for each frame with a predetermined modulo M,
   a third area (D) for carrying a repeat request number which is forwarded from a receiver side to a transmitter side requesting transmission of a frame, and
   a fourth area (E) for carrying an error detection code for a frame,
   a fifth area (A) for carrying a number which shows how much user data is filled in said first area (B),
   said transmitter side comprises at least;
   a transmit buffer memory (62) storing said first area (B), said fifth area (A) and said second area (C) of said frame by at least a modulo number of frames,
   frame assemble means (70) for assembling a frame with a user data and modifying a part (B_n) in said first area (B) so that said part (B_n) differs from the corresponding part in a frame having the same frame number as that of a current frame in a preceding modulo, and storing assembled frame in said memory (62),
   means (52) for deciding a frame for transmission according to a request number in the area (D) of a request frame from a receiver side, where a request frame within a predetermined round trip delay time is disregarded,
   means (66) for filling said fourth area (E) with an error detection code, and transmitting an assembled frame to a receiver side,
   a receiver side comprises;
   means (40) for detecting a transmission error in a frame by using an error code in said fourth area (E),
   a receive buffer memory (46) storing receive frames by at least a modulo of frames,
   means (54) for deciding a request frame to a transmit side with a request frame number (D) which is next frame of the latest received frame defined in the area (C) in case of no transmission error, or a frame which an error is detected,
   means (64) for filling said area (D) with a request frame number according to the decision by said means (54), and transmitting a request frame to a transmitter side, and
   means (66) for transmitting an output of said means (64) to said transmitter side with filling an error detection code to said output of said means (64),

   characterized in that:

   said receiver side comprises further comparison means (68) for comparing said part (B_n) in a first area (B) in a current received frame with corresponding part (B_n) in corresponding frame having the same frame number as that of said current received frame in a preceding modulo stored in said receive buffer memory (46), and deciding whether to disregard said current received frame when former coincides with latter since said current received frame has previously been received, or to take said current received frame and update content of said receive buffer memory (46) with said current received frame when former differs from latter since said current received frame is a newly received frame.

2. System for re-transmission according to claim 1, wherein;

   said user data has a plurality of words each of which has a plurality of bits, so that said first area has capacity of n number of words, where n is an integer larger than 2,
   said part of said first area is last word area in said first area,
   said fifth area (A) for carries a number showing how many words of a user data said first area carries, and
   said transmitter side comprises further means for transferring last word of a user data to a succeeding frame, filling n-1 in said fifth area, and insert in a last word area (B_n) of said first area (B) a data which differs at least one bit from a data in a last word area of a first area in the frame of the same frame number as that of the current frame in a preceding modulo, when amount of said user data is equal to or exceeds capacity of said first area, and n'th word of the current frame coincides with n'th word in the

frame of the same frame number as that of the current frame in a preceding modulo.

3. System for re-transmission according to claim 2, wherein said word has 8 bits.

4. Method for re-transmission through an Selective Repeat system in a data communication for a data frame having a forward channel and a feedback channel, having a transmitter side and a receiver side,

said data frame comprising at least;
a first area (B) for carrying a user data,
a second area (C) for carrying a frame number of each frame, said frame number being incremented one by one for each frame with a predetermined modulo M,
a third area (D) for carrying a repeat request number which is forwarded from a receiver side to a transmitter side requesting transmission of a frame, and
a fourth area (E) for carrying an error detection code for a frame,
a fifth area (A) for carrying a number which shows how much user data is filled in said first area (B),
said transmitter side comprising at least the steps of; assembling said first area (B), said fifth area (A) and second second area (C) of said frame,
storing assembled frame in a transmit buffer memory (62),
deciding a frame to be transmitted according to content in said third area (D) of a request frame from a receiver side, and disregarding said request frame in a predetermined round-trip-delay (RTF),
reading the decided frame out of said memory (62) with filling an error detection code of a frame in said fourth area (E) and transmitting the frame to a receiver side
said receiver side comprising at least the steps of;
detecting a transmission error in a received frame by using an error detection code in said fourth area (E),
storing said received frame in a receive data buffer memory (46) by at least a modulo number of frames,
taking said received frame out of said memory (46) to provide a received user data,
transmitting a request frame to a transmitter side with filling a request frame number in said second area (C) according to a number in said third area (D) of a received frame,

characterized in that :

said assembling step in said transmitter side further comprises the steps of modifying a part (B_n) in said first area (B) so that said part (B_n) differs from the corresponding part in a frame having the same frame number as that of a current frame in a preceding modulo, and
said receiver side further comprises the steps of comparing said part (B_n) in a first area (B) in a current received frame with corresponding part (B_n) in a corresponding frame having the same frame number as that of said current received frame in a preceding modulo stored in said receive buffer memory (46), and deciding whether to disregard said current received frame when former coincides with latter since the current received frame has previously been received, or to take said current received frame and update content of said receive buffer memory (46) with said current received frame when former differs from latter since the current received frame is a newly received frame.

Patentansprüche

1. System für Sendewiederholung über ein Selektivwiederholungssystem bei einer Datenkommunikation für einen Datenrahmen, mit einem Vorwärtskanal und einem Rückwärtskanal, mit einer Sendeseite und einer Empfangsseite, wobei

der Datenrahmen wenigstens aufweist:

einen ersten Bereich (B) zur Aufnahme von Benutzerdaten,
einen zweiten Bereich (C) zur Aufnahme einer Rahmennummer jedes Rahmens, wobei die Rahmennummer bei jedem Rahmen mit einem vorbestimmten Modulo M um eins erhöht wird,
einen dritten Bereich (D) zur Aufnahme einer Wiederholungsanforderungsnummer, die von einer Empfangsseite zu einer Sendeseite, die die Übertragung eines Rahmens fordert, übertragen wird, und
einen vierten Bereich (E) zur Aufnahme eines Fehlerdetektionscodes für einen Rahmen,
einen fünften Bereich (A) zur Aufnahme einer Zahl, die anzeigt, welche Benutzerdatenmenge in dem ersten Bereich (B) aufgenommen wurde,

wobei die Sendeseite wenigstens aufweist:

einen Sendepufferspeicher (62) zum Speichern des ersten Bereichs (B), des fünften Bereichs (A) und des zweiten Bereichs (C)

des Rahmens von wenigstens einer Modulo-Zahl von Rahmen,
Rahmenzusammensetzungsmittel (70) zum Zusammensetzen eines Rahmens mit Benutzerdaten und zum Modifizieren eines Teils (B_n) des ersten Bereichs (B) derart, daß sich dieser Teil (B_n) von dem entsprechenden Teil eines Rahmens mit der gleichen Rahmennummer wie die eines augenblicklichen Rahmens in einem vorhergehenden Modulo unterscheidet, und zum Speichern des zusammengesetzten Rahmens in dem Speicher (62),
Mittel (52) zum Bestimmen eines Rahmens für eine Übertragung entsprechend einer Anforderungsnummer in dem Bereich (D) eines Anforderungsrahmens von einer Empfangsseite, wobei ein innerhalb einer vorbestimmten Hin- und Rücklaufzeit liegender Anforderungsrahmen nicht berücksichtigt wird,
Mittel (66) zum Füllen des vierten Bereichs (E) mit einem Fehlerdetektionscode und zum Übertragen eines zusammengesetzten Rahmens zu einer Empfangsseite,

wobei eine Empfangsseite aufweist:

Mittel (40) zum Detektieren eines Übertragungsfehlers in einem Rahmen durch Anwendung eines Fehlercodes in dem vierten Bereich (E),
einen Empfangspufferspeicher (46) zum Speichern von Empfangsrahmen in wenigstens einem Modulo von Rahmen,
Mittel (54) zum Bestimmen eines Anforderungsrahmens zu einer Sendeseite mit einer Anforderungsrahmennummer (D), die der nächste Rahmen des zuletzt empfangenen Rahmens ist, der in dem zweiten Bereich (C), wenn kein Übertragungsfehler aufgetreten ist, definiert ist, oder ein Rahmen ist, in dem ein Fehler festgestellt worden ist,
Mittel (64) zum Füllen des dritten Bereichs (D) mit einer Anforderungsrahmennummer entsprechend der Bestimmung des Bestimmungsmittels (54) und zum Übertragen eines Anforderungsrahmens zu einer Sendeseite und
Mittel (66) zum Übertragen einer Ausgangsgröße der Füllmittel (64) zu der erwähnten Sendeseite unter Einfügung eines Fehlerdetektionscodes in die erwähnte Ausgangsgröße des Füllmittels (64),

dadurch gekennzeichnet, daß
die erwähnte Empfangsseite ferner aufweist:

Vergleichsmittel (68) zum Vergleichen des erwähnten Teils (B_n) des ersten Bereichs (B) eines augenblicklich empfangenen Rahmens mit dem entsprechenden Teil (B_n) des entsprechenden Rahmens mit der gleichen Rahmennummer wie der des augenblicklich empfangenen Rahmens in einem vorhergehenden Modulo, der in dem erwähnten Empfangspufferspeicher (46) gespeichert ist, und zum Bestimmen, ob der erwähnte augenblickliche Empfangsrahmen nicht zu berücksichtigen ist, wenn jener mit letzterem übereinstimmt, da der erwähnte augenblicklich empfangene Rahmen zuvor empfangen wurde, oder der augenblicklich empfangene Rahmen zu nehmen und der Inhalt des Empfangspufferspeichers (46) mit dem augenblicklich empfangenen Rahmen zu aktualisieren ist, wenn jener von letzterem abweicht, da der augenblicklich empfangene Rahmen ein neu empfangener Rahmen ist.

2. System für Sendewiederholung nach Anspruch 1,

bei dem die Benutzerdaten eine Vielzahl von Wörtern aufweisen, die jeweils eine Vielzahl von Bits enthalten, so daß der erwähnte erste Bereich eine Kapazität von n Wörtern hat, wobei n eine ganze Zahl und größer als 1 ist,
der erwähnte Teil des ersten Bereichs der letzte Wortbereich in dem ersten Bereich ist,
der fünfte Bereich (A) zur Aufnahme einer Zahl dient, die angibt, wie viele Wörter aus Benutzerdaten der erste Bereich aufweist, und
die Sendeseite ferner Mittel zum Transferieren des letzten Wortes aus Benutzerdaten in einen nachfolgenden Rahmen, zum Eingeben von n-1 in den fünften Bereich und zum Einsetzen von Daten in einem letzten Wortbereich (B_n) des ersten Bereichs (B), die sich in wenigstens einem Bit von den Daten in einem letzten Wortbereich eines ersten Bereichs in dem Rahmen mit der gleichen Rahmennummer wie der des augenblicklichen Rahmens in einem vorhergehenden Modulo unterscheiden, wenn die Menge der Benutzerdaten gleich der oder größer als die Kapazität des ersten Bereichs ist und das n-te Wort des augenblicklichen Rahmens mit dem n-ten Wort in dem Rahmen mit der gleichen Rahmennummer wie der des augenblicklichen Rahmens in einem vorhergehenden Modulo übereinstimmt.

3. System für Sendewiederholung nach Anspruch 2, bei dem das Wort 8 Bits aufweist.

4. Verfahren für Sendewiederholung durch ein Selektivwiederholungssystem bei einer Datenübertragung für einen Datenrahmen, mit einem Vorwärtskanal und einem Rückwärtskanal, mit einer Sende-

seite und einer Empfangsseite,

wobei der Datenrahmen wenigstens aufweist:

einen ersten Bereich (B) zur Aufnahme von Benutzerdaten,
einen zweiten Bereich (C) zur Aufnahme einer Rahmennummer jedes Rahmens, wobei die Rahmennummer von Rahmen zu Rahmen für jeden Rahmen um 1 mit einem vorbestimmten Modulo M erhöht wird,
einen dritten Bereich (D) zur Aufnahme einer Wiederholungsanforderungsnummer, die von einer Empfangsseite zu einer Sendeseite übertragen wird, die die Übertragung eines Rahmens anfordert, und
einen vierten Bereich (E) zur Aufnahme eines Fehlerdetektionscodes für einen Rahmen,
einen fünften Bereich (A) zur Aufnahme einer Zahl, die angibt, wie viele Benutzerdaten in den ersten Bereich (B) eingegeben wurden,

wobei die Sendeseite wenigstens die folgenden Schritte aufweist: das Zusammensetzen des ersten Bereichs (B), des fünften Bereichs (A) und des zweiten Bereichs (C) des erwähnten Rahmens,

das Speichern des zusammengesetzten Rahmens in einem Sendepufferspeicher (62),
das Bestimmen eines in Abhängigkeit von dem Inhalt des dritten Bereichs (D) eines Anforderungsrahmens von einer Empfangsseite zu übertragenden Rahmens und die Nichtberücksichtigung des Anforderungsrahmens, der in einer vorbestimmten Hin- und Rücklaufzeit (RTF) liegt,
das Auslesen des bestimmten Rahmens aus dem erwähnten Speicher (22) unter Einfügung eines Fehlerdetektionscodes eines Rahmens in dem vierten Bereich (E) und das Übertragen des Rahmens zu einer Empfangsseite,

wobei die Empfangsseite wenigstens die folgenden Schritte aufweist:

das Detektieren eines Übertragungsfehlers in einem empfangenen Rahmen unter Anwendung eines Fehlerdetektionscodes in dem vierten Bereich (E),
das Speichern des empfangenen Rahmens in einem Empfangsdatenpufferspeicher (46) von wenigstens einer Modulo-Zahl von Rahmen,
das Verwenden des empfangenen Rahmens aus dem Speicher (46) zur Bildung empfangener Benutzerdaten,
das Übertragen eines Anforderungsrahmens zu einer Sendeseite unter Einfügung einer Anforderungsrahmennummer in dem zweiten Bereich (C) in Abhängigkeit von einer Nummer in dem dritten Bereich (D) eines empfangenen Rahmens,

dadurch gekennzeichnet,

daß der Zusammensetzungsschritt auf der Sendeseite ferner das Modifizieren eines Teils (B_n) des ersten Bereichs (B) derart, daß sich dieser Teil (B_n) von dem entsprechenden Teil eines Rahmens mit der gleichen Rahmennummer wie die des augenblicklichen Rahmens in einem vorhergehenden Modulo unterscheidet, und
die Empfangsseite ferner das Vergleichen des erwähnten Teils (B_n) des ersten Bereichs (B) in einem augenblicklich empfangenen Rahmen mit einem entsprechenden Teil (B_n) in einem entsprechenden Rahmen mit der gleichen Rahmennummer wie der des augenblicklich empfangenen Rahmens in einem vorhergehenden Modulo, der in dem erwähnten Empfangspufferspeicher (46) gespeichert ist, und das Bestimmen, ob der augenblicklich empfangene Rahmen nicht zu berücksichtigen ist, wenn jener mit letzterem übereinstimmt, da der augenblicklich empfangene Rahmen früher empfangen wurde, oder das Annehmen des augenblicklich empfangenen Rahmens und Aktualisieren des Empfangspufferspeichers (46) mit dem augenblicklich empfangenen Rahmen, wenn jener von letzterem abweicht, da der augenblicklich empfangene Rahmen ein neu empfangener Rahmen ist, aufweist.

Revendications

1. Système de ré-émission par un système à répétition sélective de communication de données, d'une trame de données, ayant un canal direct et un canal de retour, ayant un côté émetteur et un côté récepteur, dans lequel :

la trame de données comprend au moins :

une première zone (B) pour contenir des données d'utilisateur,
une deuxième zone (C) pour contenir un numéro de trame pour chaque trame, le numéro de trame étant incrémenté d'une unité pour chaque trame, modulo une va-

leur prédéterminée M,
une troisième zone (D) pour contenir un numéro de requête de répétition qui est envoyé du côté récepteur au côté émetteur pour demander l'émission d'une trame, et
une quatrième zone (E) pour contenir un code de détection d'erreur pour la trame,
une cinquième zone (A) pour contenir un nombre qui indique combien de données d'utilisateur sont contenues dans la première zone (B) ;

le côté émetteur comprend au moins :

une mémoire tampon d'émission (62) stockant la première zone (B), la cinquième zone (A) et la deuxième zone (C) de la trame pour un nombre de trames au moins égal à la valeur du modulo,
un moyen d'assemblage de trame (70) pour assembler une trame et une donnée d'utilisateur et pour modifier une partie (B_n) de la première zone (B) de telle manière que la partie (B_n) diffère de la partie correspondante d'une trame de rang précédent ayant le même numéro de trame que celui de la trame courante, et pour stocker la trame assemblée dans la mémoire (62),
un moyen (52) pour décider d'une trame à émettre en fonction d'un numéro de requête dans la zone (D) d'une trame requise provenant du côté récepteur, dans lequel une requête de trame faite au cours d'une durée d'aller-retour prédéterminée n'est pas prise en compte,
un moyen (66) pour inscrire dans la quatrième zone (E) un code de détection d'erreur, et pour émettre la trame assemblée vers un côté récepteur ;

le côté récepteur comprenant :

un moyen (40) pour détecter une erreur de transmission dans une trame en utilisant le code d'erreur de la quatrième zone (E),
une mémoire tampon de réception (46) stockant un nombre de trames reçues au moins égal à la valeur du modulo,
un moyen (54) pour décider d'une trame requise au côté émetteur avec un numéro de trame requise (D) qui est la trame suivant la dernière trame reçue définie dans la zone (C) s'il n'y a pas d'erreur de transmission, ou une trame dans laquelle une erreur est détectée,
un moyen (64) pour inscrire dans la zone (D) un numéro de trame requise en accord avec la décision du moyen (54), et pour transmettre une requête de trame au côté émetteur, et
un moyen (66) pour émettre la sortie du moyen (64) par le côté émetteur en inscrivant un code de détection d'erreur dans la sortie du moyen (64),

caractérisé en ce que :

le côté récepteur comprend un moyen de comparaison supplémentaire (68) pour comparer la partie (B_n) de la première zone (B) d'une trame reçue courante à une partie correspondante (B_n) d'une trame correspondante de rang précédent ayant le même numéro de trame que celui de la trame reçue courante stockée dans la mémoire tampon de réception (46), et pour décider s'il faut ne pas prendre en compte la trame reçue courante lorsque cette première coïncide avec cette dernière puisque la trame reçue courante a été reçue auparavant, ou s'il faut accepter la trame reçue courante et mettre à jour le contenu de la mémoire tampon de réception (46) avec la trame reçue courante lorsque cette première diffère de cette dernière puisque la trame reçue courante est une trame nouvellement reçue.

2. Système de ré-émission selon la revendication 1, dans lequel ;

les données d'utilisateur comprennent une pluralité de mots dont chacun comprend une pluralité de bits, de telle manière que la première zone a une capacité d'un nombre n de mots où n est un entier supérieur à 2,
la partie de la première zone est la dernière zone de mot dans la première zone,
la cinquième zone (A) contient un nombre montrant combien de mots de données d'utilisateur la première zone contient, et
le côté émetteur comprend des moyens supplémentaires pour transférer le dernier mot de données d'utilisateur à une trame suivante, pour inscrire n-1 mots dans la cinquième zone, et pour insérer dans une zone de dernier mot (B_n) de la première zone (B) une donnée qui diffère d'au moins un bit d'une donnée dans la zone de dernier mot d'une première zone d'une trame de rang précédent de même numéro de trame que celui de la trame courante, lorsque la quantité de données d'utilisateur est égale à ou est supérieure à la capacité de la première zone, et quand le $n^{ième}$ mot de la trame courante coïncide avec le $n^{ième}$ mot de la trame de rang précédent de même numéro de trame que celui de la trame courante.

3. Système de ré-émission selon la revendication 2, dans lequel le mot comporte 8 bits.

4. Procédé de ré-émission par un système à répétition sélective de communication de données, d'une trame de données, ayant un canal direct et un canal de retour, ayant un côté émetteur et un côté récepteur, dans lequel :

la trame de données comprend au moins :

une première zone (B) pour contenir des données d'utilisateur,
une deuxième zone (C) pour contenir un numéro de trame pour chaque trame, le numéro de trame étant incrémenté d'une unité pour chaque trame, modulo une valeur prédéterminée M,
une troisième zone (D) pour contenir un numéro de requête de répétition qui est envoyé du côté récepteur au côté émetteur pour demander l'émission d'une trame, et
une quatrième zone (E) pour contenir un code de détection d'erreur pour la trame,
une cinquième zone (A) pour contenir un nombre qui indique combien de données d'utilisateur sont: contenues dans la première zone (B) ;

le côté émetteur comporte au moins les étapes suivantes :

assembler la première zone (B), la cinquième zone (A) et la deuxième zone (C) de la trame,
stocker la trame assemblée dans une mémoire tampon d'émission (62),
décider d'une trame à émettre en fonction du contenu de la troisième zone (D) d'une trame requise provenant du côté récepteur, et ne pas prendre en compte la requête de trame dans une durée d'aller-retour prédéterminée (RTF),
lire la trame décidée dans la mémoire (62) et inscrire un code de détection d'erreur de la trame dans la quatrième zone (E) et émettre la trame vers un côté récepteur ;

le côté récepteur comporte au moins les étapes suivantes :

détecter une erreur de transmission dans une trame reçue en utilisant un code de détection d'erreur de la quatrième zone (E),
stocker la trame reçue dans une mémoire tampon de réception de données (46) pour un nombre de trames au moins égal à la valeur du modulo,
lire la trame reçue dans la mémoire (46) pour fournir une donnée d'utilisateur reçue,
fournir une trame requise au côté émetteur en inscrivant un numéro de trame requise dans la deuxième zone (C) en fonction du nombre dans la troisième zone (D) de la trame reçue,

caractérisé en ce que :

l'étape d'assemblage du coté émetteur comporte l'étape supplémentaire suivante :

modifier une partie (B_n) de la première zone (B) de telle manière que la partie (B_n) diffère d'une partie correspondante d'une trame de rang précédent ayant le même numéro de trame que celui de la trame courante, et
le coté récepteur comporte les étapes supplémentaires suivantes :

comparer la partie (B_n) de la première zone (B) de la trame reçue courante à la partie correspondante (B_n) d'une trame correspondante de rang précédent ayant le même numéro de trame que celui de la trame reçue courante stockée dans la mémoire tampon de réception (46), et
décider s'il faut ne pas prendre en compte la trame reçue courante lorsque cette première coïncide avec cette dernière puisque la trame reçue courante a été reçue auparavant, ou s'il faut accepter la trame reçue courante et mettre à jour le contenu de la mémoire tampon de réception (46) avec la trame reçue courante lorsque cette première diffère de cette dernière puisque la trame reçue courante est une trame nouvellement reçue.

Fig. 1

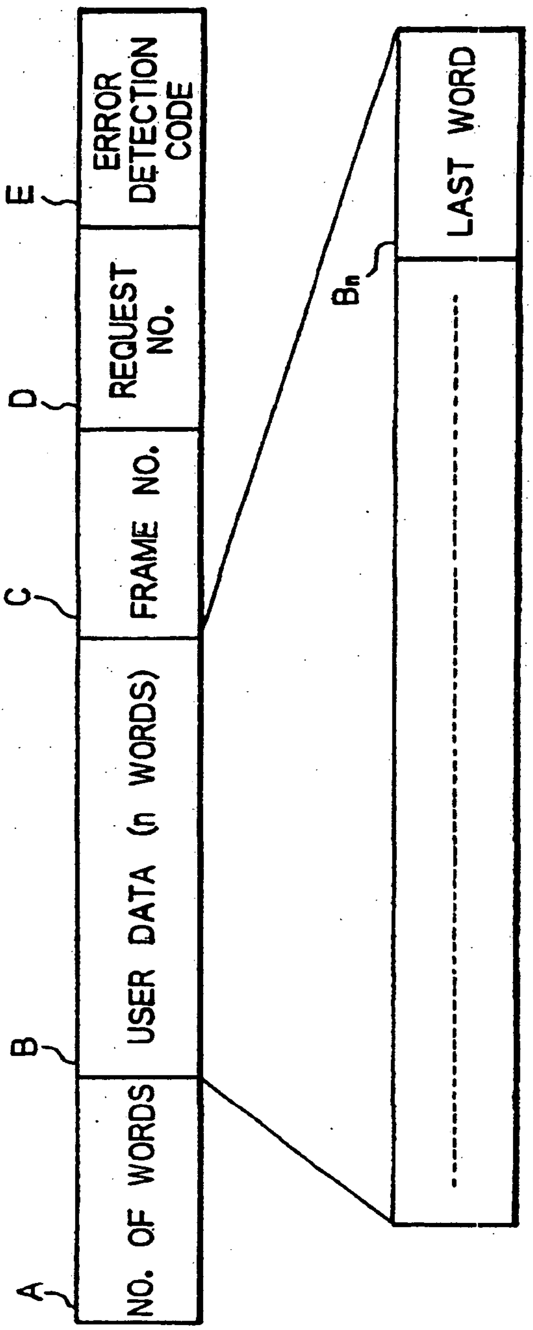

A
NO. OF WORDS
B
USER DATA (n WORDS)
C
FRAME NO.
D
REQUEST NO.
E
ERROR DETECTION CODE
Bn
LAST WORD

Fig. 2

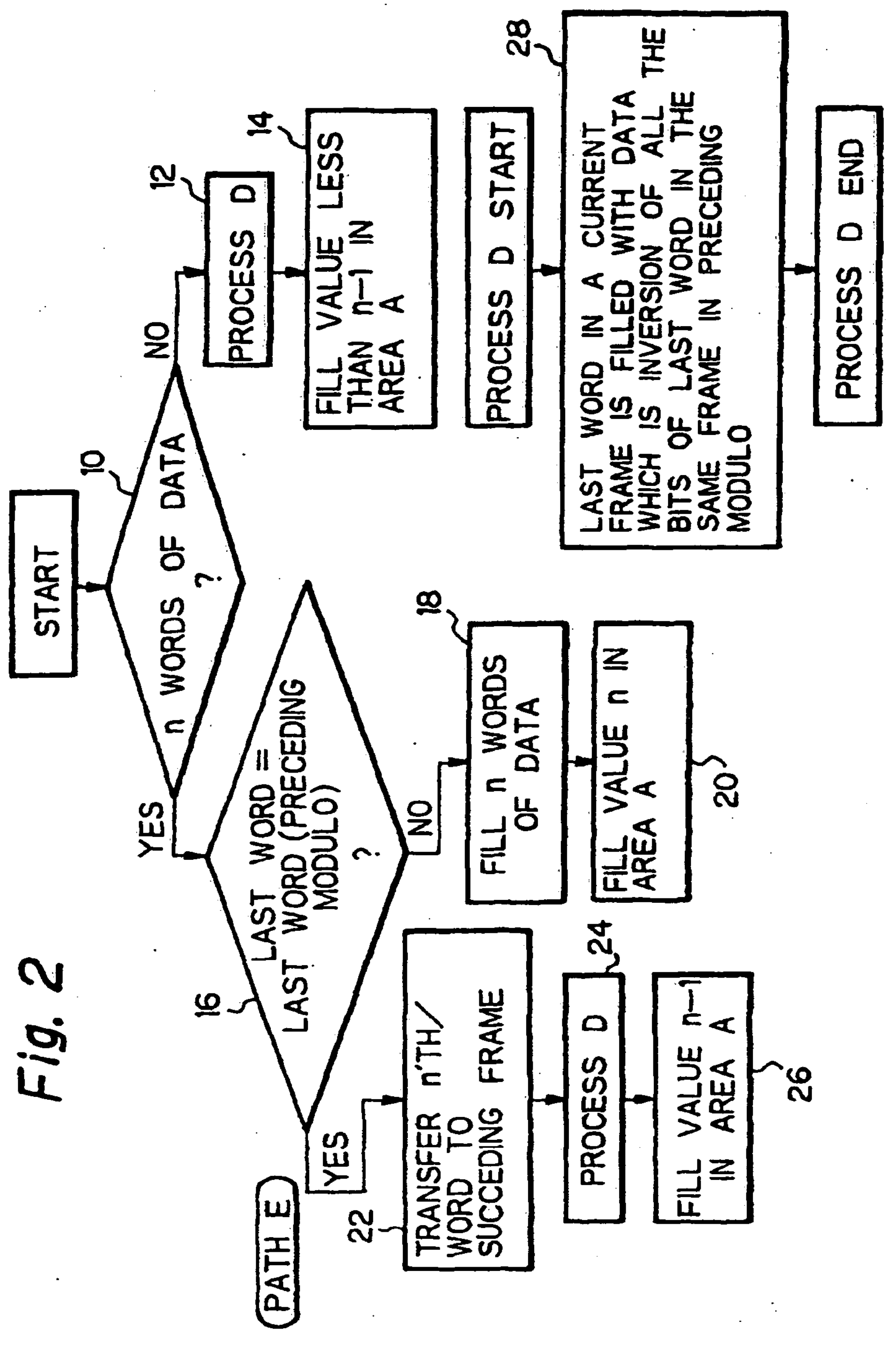

START
n WORDS OF DATA ?
10
YES
NO
12
PROCESS D
14
FILL VALUE LESS THAN n−1 IN AREA A
16
LAST WORD = LAST WORD (PRECEDING MODULO) ?
YES
NO
18
FILL n WORDS OF DATA
20
FILL VALUE n IN AREA A
PATH E
22
TRANSFER n'TH/ WORD TO SUCCEDING FRAME
24
PROCESS D
26
FILL VALUE n−1 IN AREA A
PROCESS D START
28
LAST WORD IN A CURRENT FRAME IS FILLED WITH DATA WHICH IS INVERSION OF ALL THE BITS OF LAST WORD IN THE SAME FRAME IN PRECEDING MODULO
PROCESS D END

Fig. 3

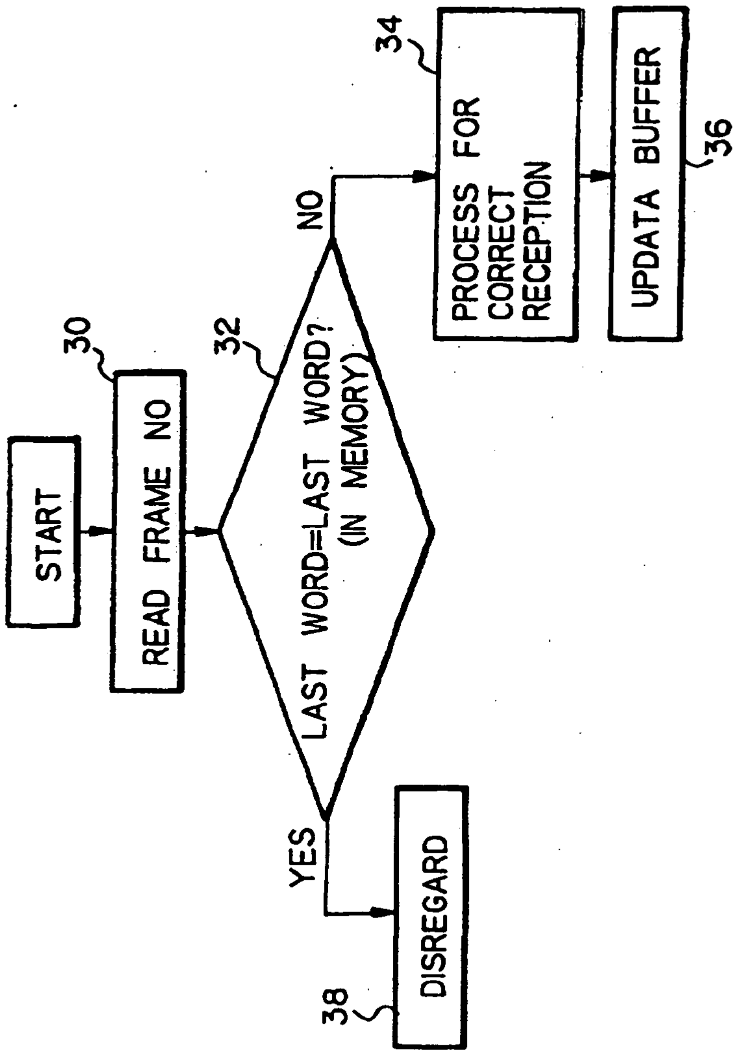

START
READ FRAME NO
30
LAST WORD=LAST WORD?
(IN MEMORY)
32
YES
NO
DISREGARD
38
PROCESS FOR
CORRECT
RECEPTION
34
UPDATA BUFFER
36

Fig. 4

Fig. 4A	Fig. 4B

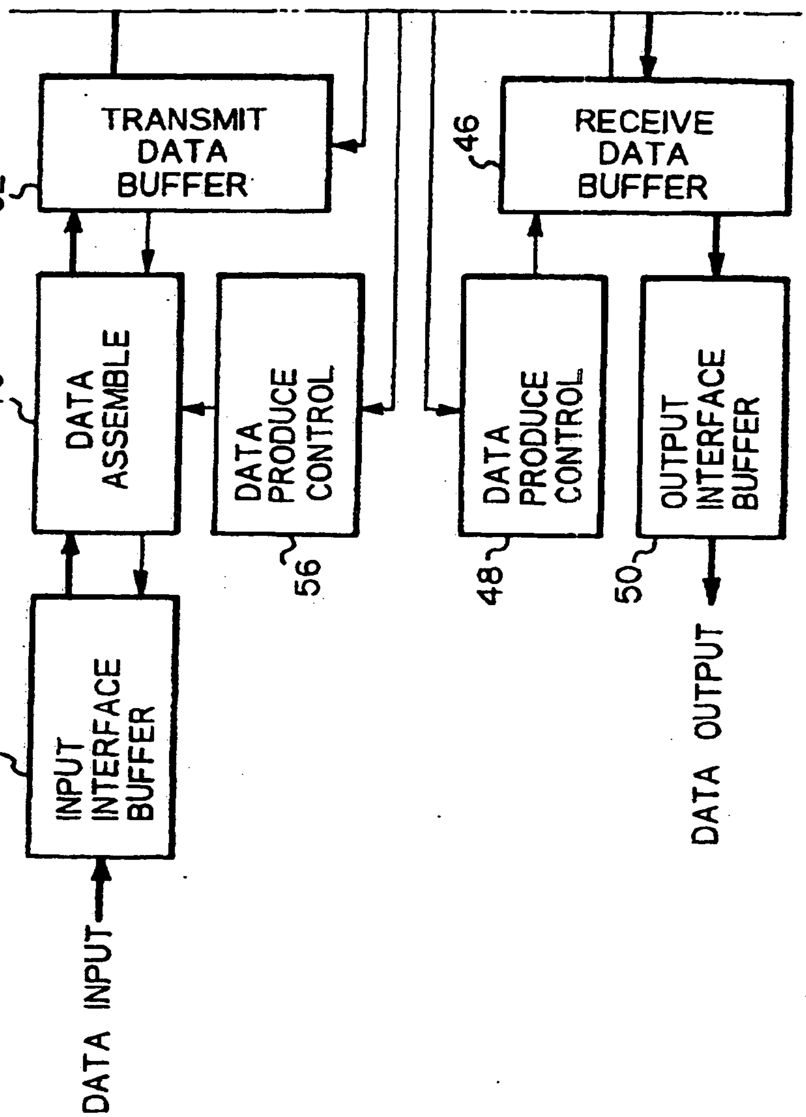


Fig. 4A

Fig. 4B

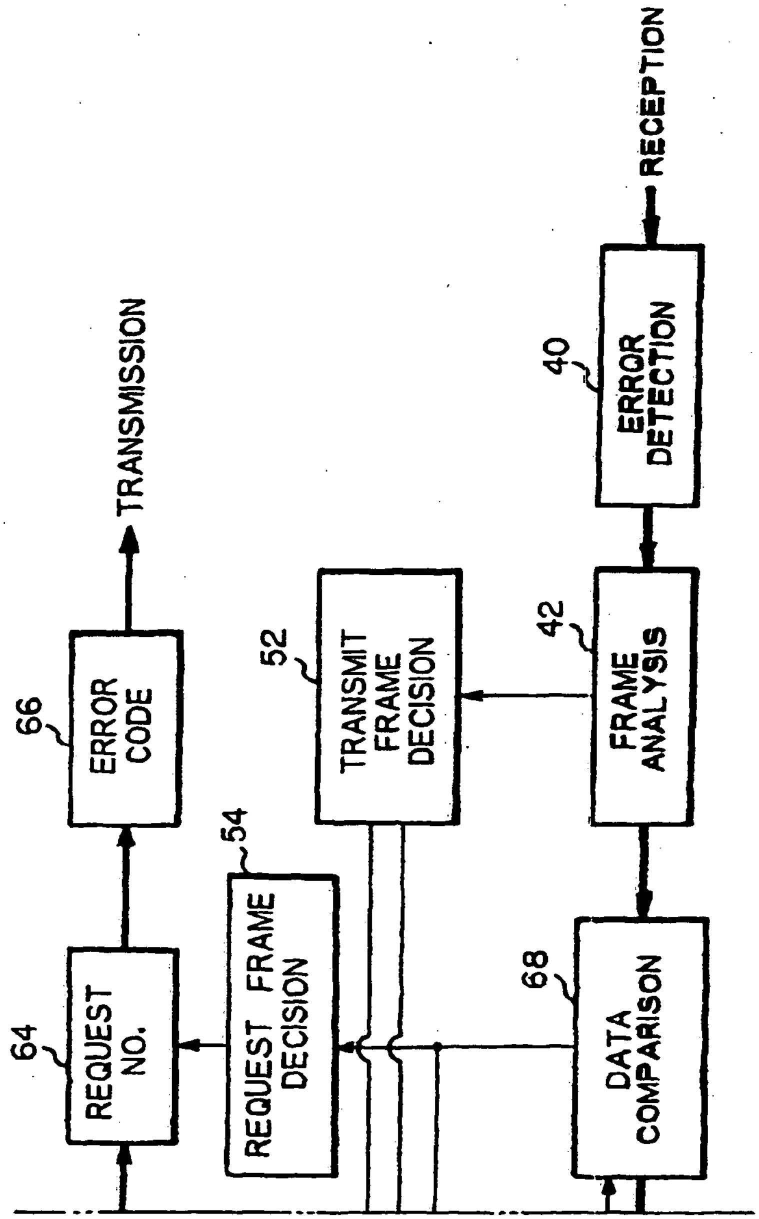

RECEPTION
40
ERROR DETECTION
42
FRAME ANALYSIS
52
TRANSMIT FRAME DECISION
68
DATA COMPARISON
54
REQUEST FRAME DECISION
64
REQUEST NO.
66
ERROR CODE
TRANSMISSION

Fig. 5

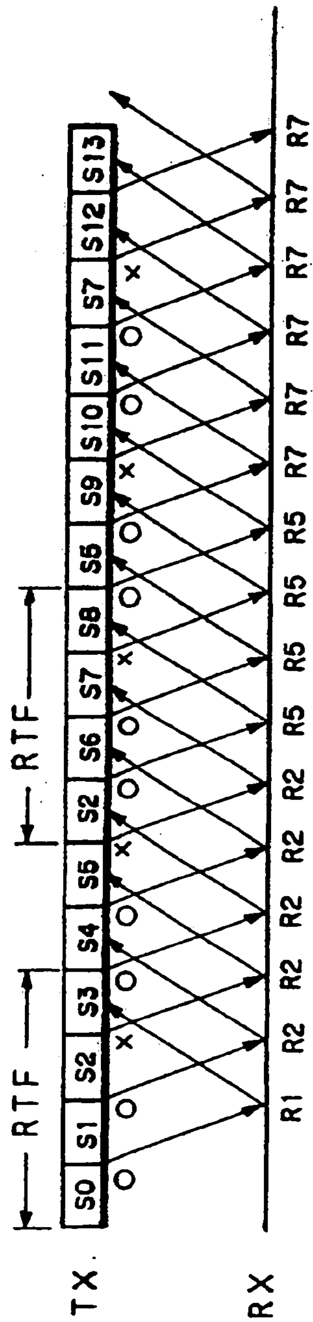

TX
RX
RTF
RTF
S0
S1
S2
S3
S4
S5
S2
S6
S7
S8
S5
S9
S10
S11
S7
S12
S13
R1
R2
R2
R2
R2
R2
R5
R5
R5
R5
R7
R7
R7
R7
R7
R7

Fig. 6

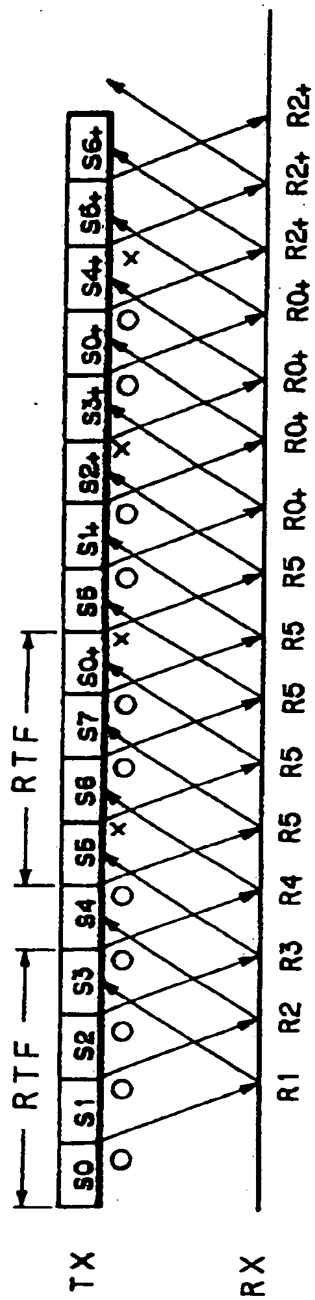

TX
RX
RTF
RTF
S0
S1
S2
S3
S4
S5
S6
S7
S0+
S5
S1+
S2+
S3+
S0+
S4+
S5+
S6+
R1
R2
R3
R4
R5
R5
R5
R5
R5
R0+
R0+
R0+
R0+
R2+
R2+
R2+

Fig. 7

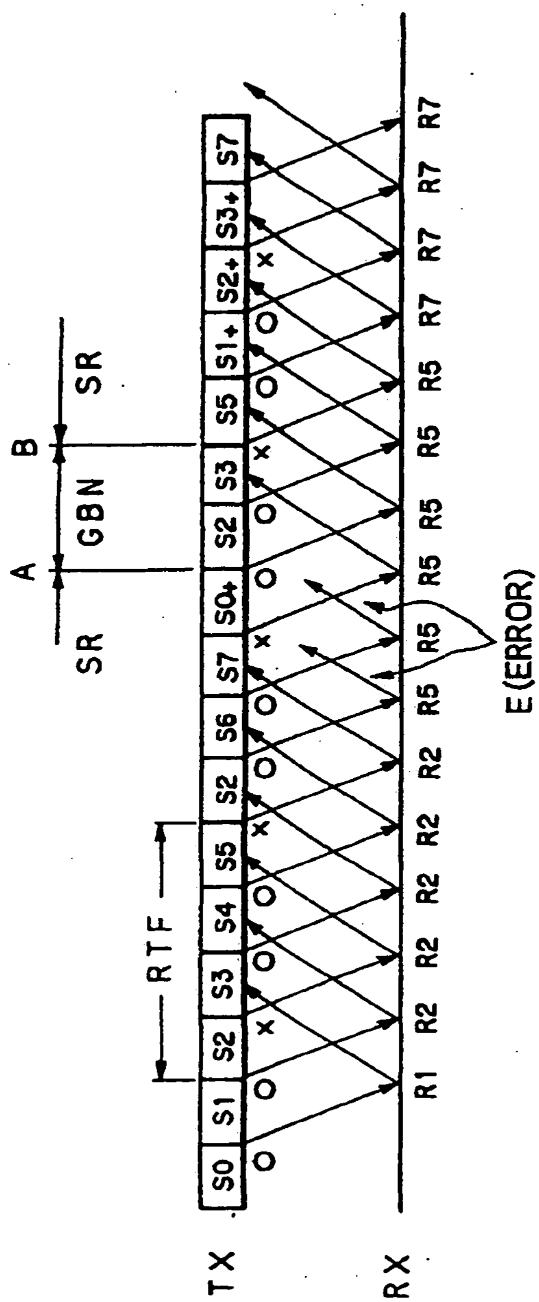

TX
RX
S0
S1
S2
S3
S4
S5
S2
S6
S7
S0+
S2
S3
S5
S1+
S2+
S3+
S7
R1
R2
R2
R2
R2
R2
R5
R5
R5
R5
R5
R5
R7
R7
R7
R7
RTF
SR
A
GBN
B
SR
E(ERROR)

Fig. 8 PRIOR ART

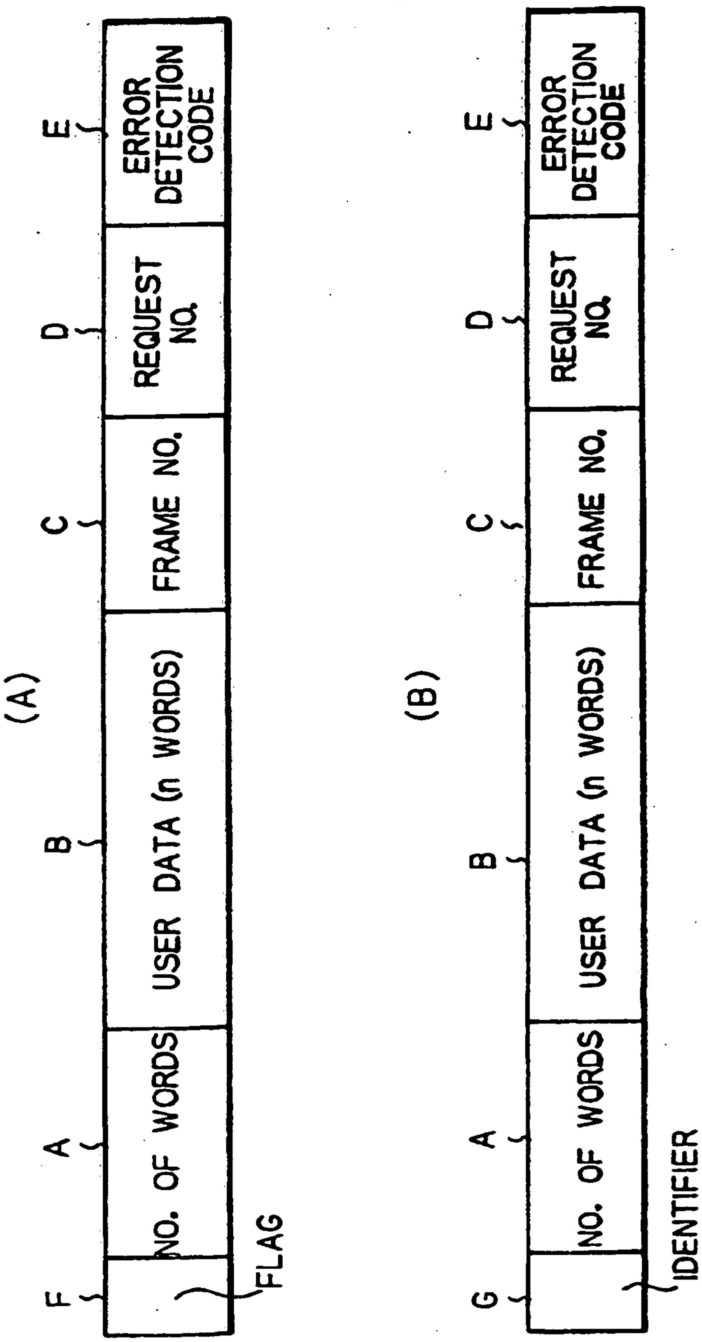


Fig. 9

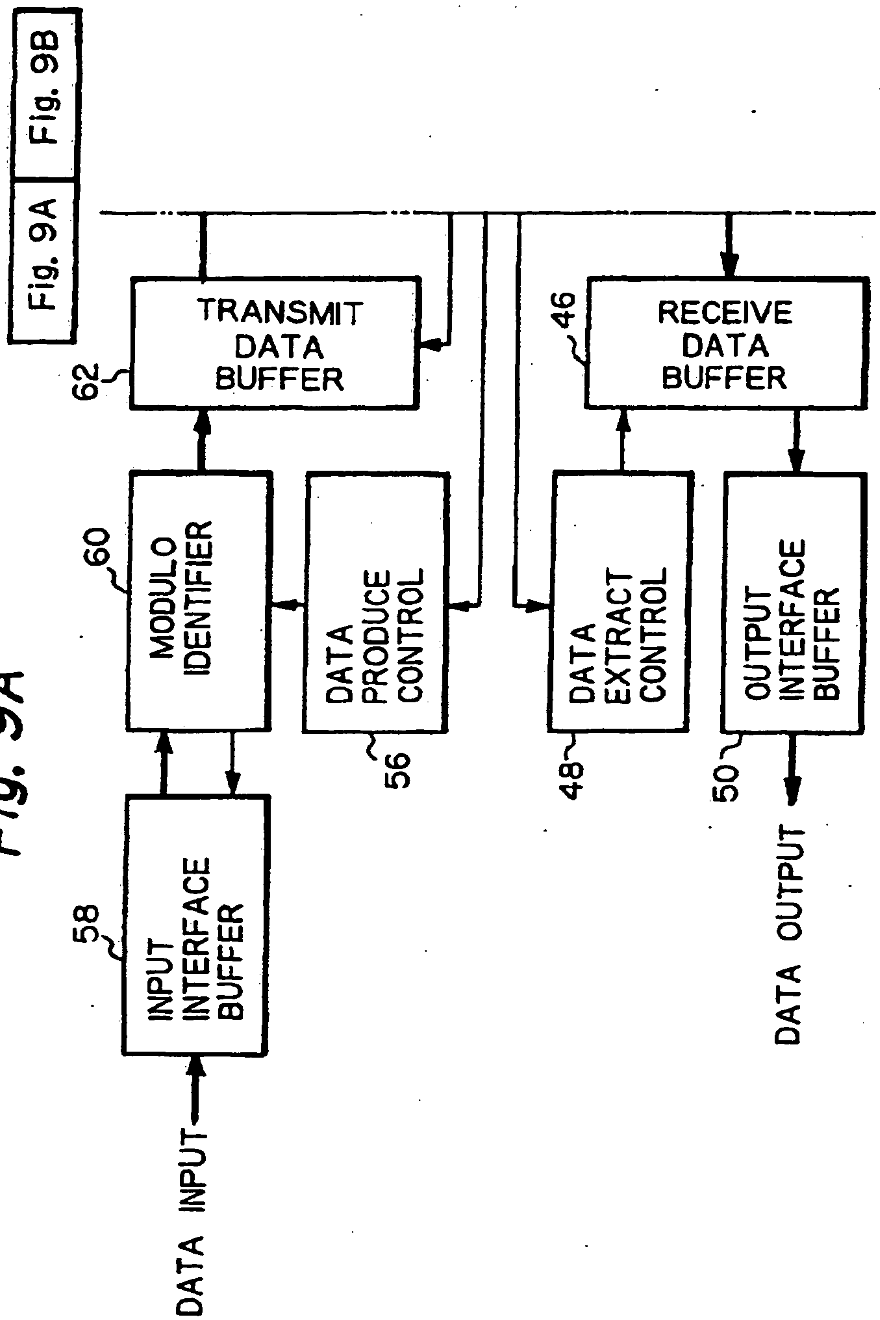


Fig. 9A
Fig. 9B
TRANSMIT DATA BUFFER
62
RECEIVE DATA BUFFER
46
MODULO IDENTIFIER
60
DATA PRODUCE CONTROL
56
DATA EXTRACT CONTROL
48
OUTPUT INTERFACE BUFFER
50
INPUT INTERFACE BUFFER
58
DATA INPUT
DATA OUTPUT

Fig. 9A

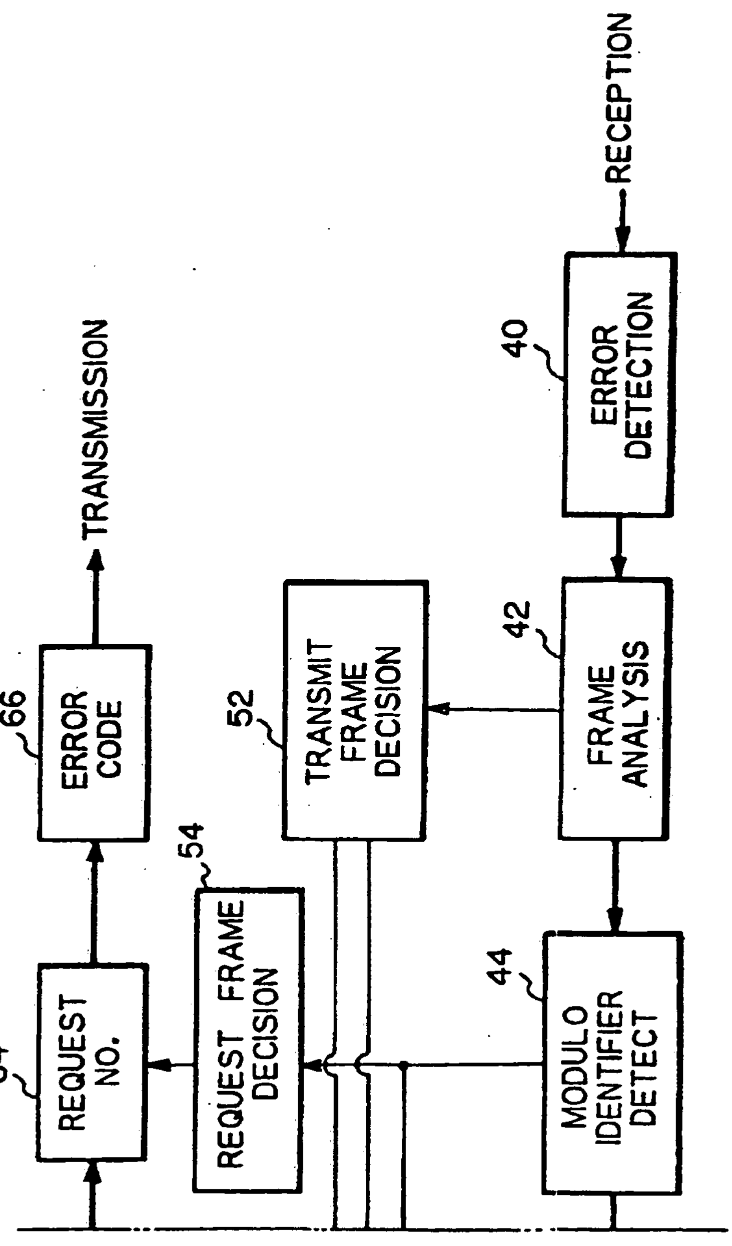
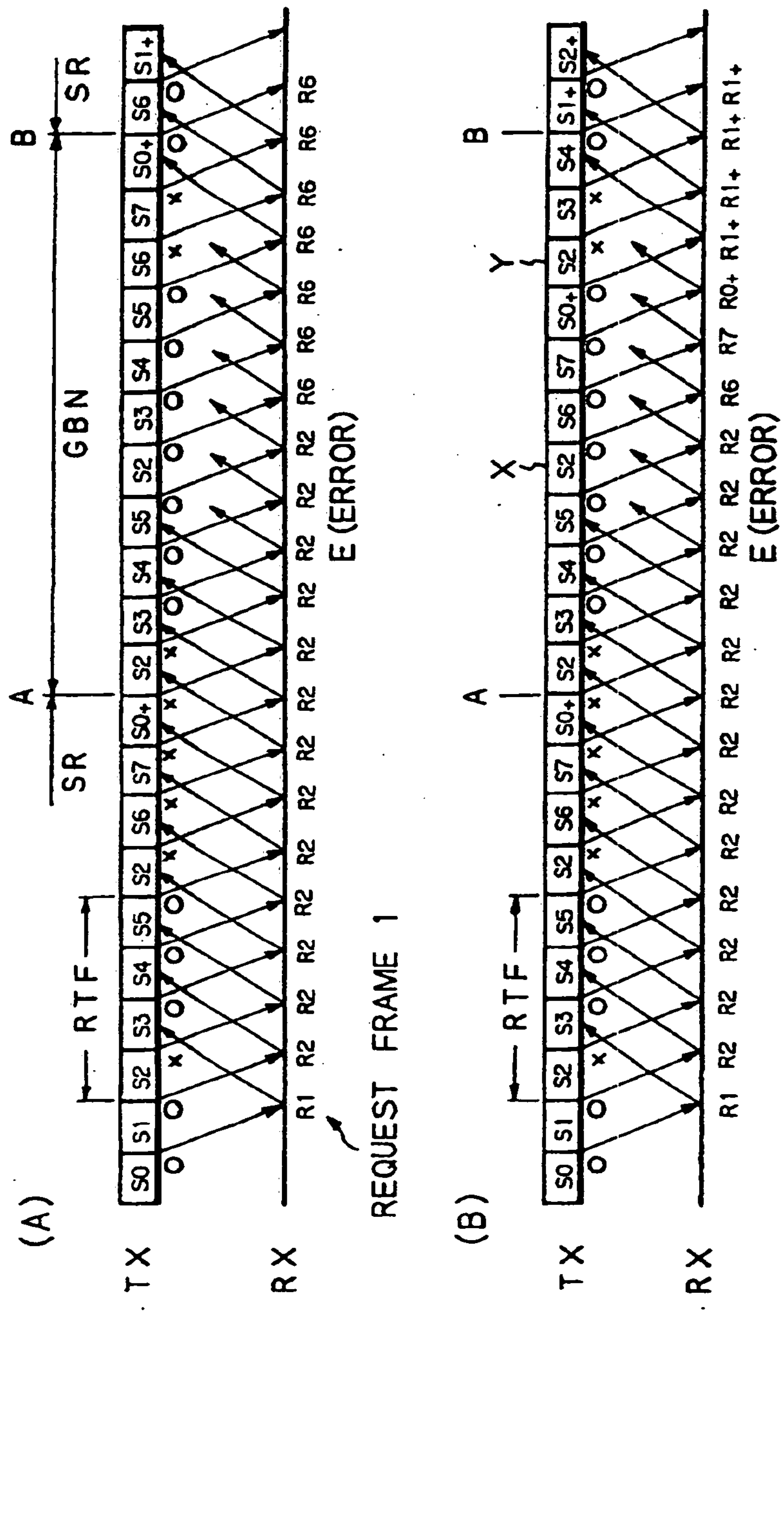

RECEPTION
TRANSMISSION
40
ERROR DETECTION
42
FRAME ANALYSIS
44
MODULO IDENTIFIER DETECT
52
TRANSMIT FRAME DECISION
54
REQUEST FRAME DECISION
64
REQUEST NO.
66
ERROR CODE

Fig. 9B

Fig. 10



(A)
TX
RX
RTF
SR
GBN
A
B
S0 S1 S2 S3 S4 S5 S2 S6 S7 S0+ S2 S3 S4 S5 S2 S3 S4 S5 S6 S7 S0+ S6 S1+
R1 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R6 R6 R6 R6 R6 R6 R6 R6
REQUEST FRAME 1
E (ERROR)
(B)
TX
RX
RTF
A
B
X
Y
S0 S1 S2 S3 S4 S5 S2 S6 S7 S0+ S2 S3 S4 S5 S2 S6 S7 S0+ S2 S3 S4 S1+ S2+
R1 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R2 R6 R7 R0+ R1+ R1+ R1+ R1+
E (ERROR)